U.S. DEPARTMENT OF AGRICULTURE

REFERENCE SLIP

DATE 6-22-71

TO

J. A. Fluno
Plant Industry, No. Bldg.
Beltsville

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REMARKS

FROM

D. L. Williams
Hyattsville

Screwworm

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

REPLY TO ATTN OF: DC71/5/M09/71 (RH)

JUN 7 1971

MEMORANDUM

TO: AD/Associate Director

FROM: DA/Director of Medical Research and Operations

SUBJECT: Program Travel to Mexico

It is requested that permission be granted for travel to Mexico for the person designated below in connection with the Joint Mexican-American Program for the Eradication of Screwworms. This travel is programmatic in accordance with an OSSA (Code SRR) approved task in the Public Health Ecology Program at this Center. Basically, technical assistance has been offered to the U.S. Department of Agriculture in securing environmental data concerning ground temperature and humidity factors which might be provided to the joint project on a routine basis. This information should assist in the location of screwworm populations in Mexico and geographic areas where sterile flies may be optimally deployed to combat such populations. The U.S. Department of Agriculture has an approved program and an agreement with Mexico for eradication of screwworms which is awaiting federal funding for its initiation (25-30 million dollars). The U.S. Program Director is Dr. Donald Williams, Agricultural Research Service, Hyattsville, Maryland, telephone (202) DU8-8625.

In previous meetings with Dr. Williams and his staff, agreement has been reached that NASA-MSC will participate in this program on an experimental basis. It is believed that remote sensing data can assist materially in program planning and eradication procedures when they are effected. Preliminary to initiation of the eradication effort, the U.S. Department of Agriculture and Mexican scientists are performing experiments at a U.S. funded Experiment Station located at Cotaxtla, Veracruz, Mexico. This is in an area previously flown by NASA remote sensing aircraft for the Mexican government (Popaloapan Valley-Mission 706). The Mexican remote sensing project is continuing to fly the area using Mexican aircraft and technicians. It is proposed that studies be conducted to determine if remote sensing is useful at the experimental plot prior to committing resources for a major effort required during the

eradication campaign. To accomplish this objective it will be necessary for U.S. scientists to travel occasionally to the Experimental Site and to Mexico City for scientific discussions and exchange of technical information.

The USDA has made arrangements for a preliminary trip now scheduled for June 14-19, 1971 by Dr. C. M. Barnes, MSC, and the agriculture representative, Dr. Frank Gonzales.

The following information is provided per guidelines of FMM 9740-61.

Name of Traveler:

Dr. Charles M. Barnes
DC71/Chief, Radiological Health Team
Manned Spacecraft Center

Date of Travel:

June 14 - 19, 1971

Specific Places and Areas to be Visited in Mexico:

Cotaxtla, Veracruz, Mexico and Mexico City, D.F. Mexico

Purpose:

See paragraph 1, this memorandum

Justification:

Screwworms have been eradicated from the United States and a barrier of sterile flies is being maintained along the border between Mexico and the United States. There are no Experimental Test Sites for this insect in the United States.

Equipment to be Imported into Mexico:

None

Items to be Exported from Mexico:

None

Names and Affiliation of Personnel to be Contacted while in Mexico:

a. Dr. Alan Heflin
Senior USDA Representative
Mexico, D.F.

b. Mexican officials as introduced by Drs. Heflin and Gonzales at the Cotaxtla Experiment Station.

Charles A. Berry Jr. D

Charles A. Berry, M.D.

Enclosure
NASA Form 386

DC71/CMBarnes:lmr:5/24/71:4251

CK 6/10/71
JAB

Screwworm

USDA:ARS:Animal Health Division
Federal Center Building
Hyattsville, Maryland

X

5/24/71

X

D. L. Williams, Chief Staff Veterinarian DUB-8625

TELETYPE

A. A. Reflin
Tres Picos 79
Colonia Polanco
Mexico City, Mexico

Dr. Charles Barnes, NASA veterinarian, informed us he was going to Mexico City and Cotaxtla, Veracruz, the week of June 14 for the purpose of contacting U.S. and Mexican Government personnel about remote sensing programs in connection with screwworm activities.

R. S. Sharman
Director

cc:
C. H. Schmidt, ENT, Beltsville

USDA:ARS:Animal Health Division
Federal Center Building
Hyattsville, Maryland

X

5/24/71

X

B. L. Williams, Chief Staff Veterinarian DOB-8825

TELEXTER

A. A. Baffis
Tres Piens 75
Colonia Polanco
Mexico City, Mexico

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R. S. Sharman
Director

cc:
C. H. Schmidt, ENT, Beltsville

U.S. DEPARTMENT OF AGRICULTURE

REFERENCE SLIP

DATE 22 JUL 71

TO DR. C.H. HOFFMAN-ARS-ENT
RM 104, NO. BLDG., PIS,
BELTSVILLE

Schmidt
Cat

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REMARKS

COPY SENT TO DR. KNIPLING, EDMINSTER + THOMAS, DELAY, SHARMAN

FROM ROBERT H. MILLER

GPO : 1964 OF—742-059 FORM AD-514 (8-64)

Screwworm

JUL 26

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

CHH
CCC
LBR
AKB
JEG
FJL

REPLY TO ATTN OF: DC71/7/M18/71

JUL 7 1971

MEMORANDUM

TO: DC/Chief, Preventive Medicine Division

FROM: DC71/Chief, Radiological Health Team

SUBJECT: Trip Report - June 20-26, 1971 - Mexico DF and Cotaxtla, Veracruz, Mexico

Reason for Travel

Determine feasibility of use of NASA remote sensors for sensing environmental factors which might assist in the joint USDA - Mexico program for eradication of screwworms.

Contacts

Dr. A. Heflin, Dr. W. Tarver, Dr. Marco Villaseñor of the Mexican-American Commission for the Prevention of Foot and Mouth Disease and Screwworms. Sr. Ing. Ramon Salis, Secretariat of the President, Department of Photo Interpretation; Sr. Ing. Raul Higuera Mota, and Sr. Ing. Sergio Padilla Guzman, Comisión Nacional del Espacio Exterior (Mexico's NASA); Sr. Ing. Carlos Castillo Tejero, Sr. Ing. Efrain Castaneda Alderete, Sr. Ing. Remigio Valdes Gamez, Members of Mexico's Committee for Remote Sensing; Dr. Juan Villanueva and Sr. Ing. Velasco, Cotaxtla Experiment Station, Cotaxtla, Veracruz, Mexico.

Discussions

Upon arrival in Mexico City, basic discussions were held with Drs. Heflin, Tarver, and Villaseñor concerning the current screwworm program in Mexico and the possibilities for the use of remote sensing to assist in defining the habitat conducive to the growth and multiplication of the screwworm fly. These gentlemen were in accord that there were definite factors of environment which influence materially the growth of this insect in the field. Considerable information is currently being collected and processed by computer. Data collected include the total numbers of screwworm cases encountered by municipio, the type of animal affected, and local climatological conditions. These inputs are collected by 60 personnel scattered primarily in northern Mexico, and maps of the

disease incidence along with environmental factors is being plotted.

In summary there appears to be a definite correlation between humidity and temperature conditions and the spread of the screwworm fly.

At the Cotaxtla Agricultural Experiment Station located near Paso del Toro, Veracruz, an effort is being made to determine the incidence of the screwworm insect in the lowlands of Veracruz State. Flies are marked in the pupal stage by means of paint and their capture is recorded at traps located various distances from the release point. Flies from various parts of Mexico are being compared under field conditions to study genetic influences. Tests are also being made of the effectiveness of various insecticides. A tremendous quantity of detailed information is available at this site but was not available for me to carry away since there were no extra copies nor was there a machine available for making such copies. Perhaps of greatest interest to our proposed program was the fact that the numbers of flies in the northern Veracruz region increase tremendously during the months of January through June which is the dry season and drop to levels of less than 50% of the maximum during the balance of the year which is the rainy season. In climates which lack the rainy-dry season variability, populations appear static. This might indicate that it would be more productive to attempt an eradication program during the rainy season when the population is at its lowest. In the view of the Cotaxtla experimentors there are significant differences between both humidity and temperature extremes which could be profitably utilized in planning an eradication effort. It is significant that the Cotaxtla station is not currently conducting research in the mountainous regions of Veracruz where extremes in temperature could be studied.

Both the U.S. and Mexican staff agree that an experimental test site including variable temperature and humidity should be secured and a program of study concerning these effects on insects in the field should be accomplished, particularly as relates to remote sensing. One area near Ciudad Victoria in the State of Tamaulipas was suggested as a prime area for consideration. It has been a continual hot spot of screwworm infestation even though it is less than 100 miles south of the Texas border and has been seeded with sterile flies on a continuing basis. The proposed terrain consists of low-land tropical jungle and a dry, yet low altitude plain separated by a mountain range. The mountain range apparently blocks moisture coming in from the Gulf Coast providing a wide fluctuation in temperature and humidity conditions within a relatively small area. This site appears favorable from the point of view that it is near the U.S. Border including the Weslaco, Texas Experiment Station of the USDA which is being over-flown at routine intervals for various agricultural remote sensing purposes. Secondly, it might be feasible to install remote sensors on the Mission, Texas aircraft which fly over

this area at routine intervals to drop sterile flies.

A second area proposed is near Torreon in the State of Coahuila. This area is located in the central part of northern Mexico which has never been adequately covered with sterile flies. Again, there is a low-land valley surrounded by large mountains and a river which undoubtedly contributes to the continuing population of flies in the area. There are extremes of temperature, altitude, and humidity which might be sensed remotely to assist in determining growth and distribution of the screwworm fly. A consideration favoring this test site is that it is reasonably close to the Texas border, about 350 miles south of Big Bend National Park. Another distinct advantage is that the fly populations have not been significantly influenced by sterile fly releases or the use of large quantities of insecticides. A disadvantage might be that the terrain is inordinately mountainous causing some danger to low level flying which may be required for environmental sensing. It is suggested that a committee of Mexican-American screwworm officials plus Mexican-American remote sensing officials visit both sites if it appears feasible that one or more of the sites should be used in the trial program. Preliminary investigation for these sites is currently being accomplished by the Mexico-American Commission (Drs. Tarver and Villaseñor). Other sites may appear more favorable as a result of their investigation.

A visit was made with Sr. Ing. Ramon Solis, Department of Photo Interpretation, Secretariat of the President, in Mexico City. Ing. Solis had previously worked with U.S. space officials on Mission 91, the joint Mexican-American effort to determine efficiency of remote sensing for various country development projects. Ing. Solis has prepared and published numerous new maps of Mexico resulting from their remote sensing and photographic work throughout the Republic. It is evident that these maps will mean much to scientific personnel working toward the development of the Mexico industrial and agricultural complex. It is interesting to note that neither Ing. Solis nor any of the Mexican officials had thought of remote sensing as a tool for public health. Dr. Villanueva (Cotaxtla) was not aware that Mission 91 had been flown nor that data covering experimental areas for which he is responsible was available from the Mexican government. He suggested that at Cotaxtla they were doing much grasslands research including several botanical diseases and insect pests (spittle bug) in the Popaloapan Valley. He planned to make inquiry for assistance in studying the broad geographic problem associated with the disease studies in progress.

Ings. Higuera and Padilla from the Mexican Space Commission were at first worried that a NASA-Houston person was visiting in Mexico talking about remote sensing without their leadership. It was ex-

plained that the problem was being adequately staffed by the Mexican-U.S. Departments of Agriculture and that the use of remote sensors was an innovation which hopefully could be utilized to assist with an agricultural-public health problem. Further, the current conferences, were the first discussions between our two agencies on this subjects, were preliminary in nature, and would be fully staffed through international channels before any firm action is taken. It was delightful to note the enthusiasm of these two engineers for such a program and it is believed that we will have complete cooperation by the Mexican Space Commision in any joint effort. Leadership for such a program within Mexico should perhaps be joined between the Space Commision and the Mexican Department of Agriculture since both would be involved in planning the research effort.

On Friday, June 25, personnel of the Mexican Space Commission invited other members of their remote sensing committee including Sr. Ing. Valdes of the National Council of Science and Technology for Mexico; and Sr. Ing. Castaneda, the Director General for Geography and Meteorology for the Mexican Department of Agriculture and Sr. Ing. Castillo of the Mexican Institute of Petroleum to listen to a 30-minute presentation on remote sensing as applied to public health. The response was most interesting and the committee agreed it was a "must" that a public health official be invited to join their national committee on remote sensing to permit utilization of this new science for the betterment of Mexican health.

Sr. Ing. Higuera and Dr. Villasenor are expected to visit Houston and the Mission, Texas screwworm plant in the not too distant future to discuss informally the steps for beginning the joint research program. Dr. Barnes will continue coordination activities for DC71 and prepare the ground work for program approval.

CMBarnes

Charles M. Barnes

cc:
DC71/Dr. Fuller
USDA-ARS/Dr. Williams
USDA-Mexico/Dr. Heflin
SRR/Dr. Park
SRR/Dr. Jacobs
USDA/Dr. Miller
USDA-Mission/Dr. Hightower
PAHO/Mr. Hanson
TF/Mr. Holter

U.S. DEPARTMENT OF AGRICULTURE

REFERENCE SLIP

DATE 20 July, 1971

TO Dr. C. H. Schmidt

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REMARKS I suggested the Colorado area as we have more data on population there.

Barnes is also interested in mapping tsetse areas & vector breeding.

FROM BHM

Screwworm

Entomology Research

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

REPLY TO ATTN OF: DC71/7/M18/71

MEMORANDUM

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Rainy season = Hurricane season

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This area is located in the SW trapping area in the Papaloapan Valley on Dam South of Alvarado.

Ings. Higuera and Padilla from the Mexican Space Commission were at first worried that a NASA-Houston person was visiting in Mexico talking about remote sensing without their leadership. It was ex-

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Charles M. Barnes

cc:
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USDA-ARS/Dr. Williams
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PAHO/Mr. Hanson
TF/Mr. Holter

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

JUL 30 1971

OFFICE OF ADMINISTRATOR

Subject: Prospective U.S.-Mexico Scientific Exchange Program

To: K. A. Haines
Associate Director, IPD

We are in general agreement with scientific exchange in the agricultural subject matter area with Mexico. We concur with the draft agreement that scientific and technological cooperation will advance the state of science and technology of our countries and particularly that it will strengthen the bonds of friendship and understanding which is so essential between these adjoining countries.

We believe that in the field of agriculture there are more cogent and demanding justifications for close scientific cooperation between the two countries. There exists no physiographical barriers between the countries. Hence, we share many of the same problems with respect to plant and animal pests and we mutually benefit from the development of desirable organisms. None of this reasoning is new. It dates back to cooperative efforts in controlling exotic animal diseases and has recently been emphasized by the movement of VEE from Mexico to the States. Many additional undesirable organisms exist in Latin America for which Central America is the pathway into the United States. We need but to mention South American problems such as the savage African honeybee which is now advancing toward Central America. Such background serves as logical justification in favor of a joint approach to solving problems and making advances in the agricultural productivity of both of our countries.

We have listed a number of possible areas for joint participation. When logical we have classified such suggestions into the following types:

1. Exchange of scientists and technicians.
2. Joint cooperative research and training projects.
3. Organization of joint symposia or other types of meetings.

These areas of scientific cooperation are suggested witn the understanding that, as the draft agreement states, "each government will normally share the cost of discharging its respective responsibilities ...." and that, when necessary, provisions be made for funds required to be spent by the U.S. government agencies. Suggestions are enclosed.

We are hopeful these suggestions will be helpful in future negotiations with Mexico as to the type and scope of scientific exchange.

T. W. Edminster
Associate Administrator

Enclosure

1. Mr Haines
2. US-Mexico Scientific Cooperation

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

OFFICE OF ADMINISTRATOR

July 15, 1971

Subject: Prospective United States-Mexico Exchange Program and Bilateral Agreement for Scientific and Technological Cooperation

To: J. H. Starkey, Director
International Programs Division

With reference to Mr. Haines' memorandum of July 9 on the above-mentioned subject, I would like to see the categories enlarged to include plant and animal regulatory work.

F. J. Mulhern
Associate Administrator

Areas of Potential Cooperation

With Mexico in Agricultural Research

Entomology Research

1. Exchange of scientists and technicians:

   a. Plant resistance to insects. A search for germplasm of cotton and corn. Evaluation at locations such as Veracruz. Brownsville, Texas.

   b. Ecology. Mexican fruit fly and citrus black fly constantly a threat to invade U.S. Host-parasite relationships of cotton insects. Stable fly and *Dermatobia hominis* (the latter not in U.S.). Potential U.S. program sites include Weslaco, Texas; Tucson, Arizona; Gainesville, Florida; and Kerrville, Texas.

   c. Parasites of cotton and citrus insects. Exploration, propagation, and release.

2. Joint cooperative research and training projects:

   a. Problems existing in Mexico which pose a threat to the United States: Mexican fruit fly, citrus black fly, *Dermatobia hominis*, and vectors of Venezuelan equine encephalomyelitis.

   b. Insect rearing. U.S. could provide training in this area which would benefit Mexican research program.

   c. Ecology and migration. Studies involving potential movements by cabbage looper and *Heliothis* spp. Development of remote sensing as a tool to monitor population trends and for survey purposes.

   d. Alternate methods of insect control. Mexican staff could be trained in all aspects of an operational insect suppression program, the screwworm sterile male and Mexican fruit fly release programs.

   e. African bee control. Jointly undertake research to determine means of genetically altering or controlling by other means. Control should be initiated before this overagressive bee advances from South America into Mexico.

3. Organization of joint symposia or other types of meetings:

a. Mexico is part of the Southwest Branch of the Entomological Society of America. Meeting will be held in Mexico City, February 1972. This represents an ideal opportunity to initiate and increase information exchange. (Could be facilitated through "special dispensation" for foreign travel).

b. Meeting to review insect systematics, to expedite completing an inventory of North American insects, to facilitate identification and to develop manuals and guides.

c. Meeting to review biological control programs of mutual concern.

Plant Science Research

1. Exchange of scientists and technicians:

Survey, identifying and documenting the economic and cultivated plant resources of Mexico.

Specifically, the U.S. National Arboretum could train scientists and technicians here, and in Mexico, to provide Mexico with greater technical expertise in plant identification and herbarium methods and otherwise help Mexico initiate or improve an herbarium-taxonomy research program with emphasis on identifying and documenting the economic and cultivated plant resources of Mexico.

Such a program would provide Mexico with a valuable source of documented information about the plants of Mexico. The United States would benefit by the development and exchange of reliable documented information about germplasm resources.

A survey and collection of cotton germplasm would be mutually beneficial.

2. Joint cooperative research and training projects:

a. Late blight of potato control and development of potato varieties with resistance to the disease.

There is need to develop a closer liaison with research workers in Mexico on problems of late blight control, and

particularly breeding potatoes with resistance to the disease. Although the Rockefeller program has been in effect for many years, we are informed that the Mexicans have not accepted the varieties developed in that program, nor has there been the close cooperation between Rockefeller and the USDA that is desirable. Hence, it would be advantageous to have two to three persons involved in the Mexican program spend time in the U.S. and vice versa.

b. Research on diseases and insects of corn and sorghum.

The U.S. and Mexico share a mutuality of production problems in corn and sorghum, expecially with disease and insect problems. Many of the current disease and insect problems in the U.S. appear to have come to us by the way of Mexico. Included would be important pests such as corn stunt virus, downy mildew, Helminthosporium spp. and corn rootworms. Ergot is occasionally serious on corn in Mexico but does not yet occur in the U.S. The exchange of scientific and technical personnel and the development of cooperative research and training projects could be mutually beneficial to both countries in the study of the epidemiology of the diseases, the identification of genetic resistance to the pests, and the development of useful evaluation techniques and improved breeding procedures.

c. Research on wheat diseases.

The proposed U.S.-Mexico scientific exchange offers an excellent opportunity to study disease problems of wheat common to both countries. Primary among the diseases to be considered are the rusts, but various viruses and smuts should also receive attention. Cooperative epidemiological studies, including special nurseries containing specific isogenic lines and strategically located in both countries, would be of great value in monitoring the changing race pattern and would also aid in the identification of new sources for resistance for their control.

d. Research on rice.

Rice is important to both Mexico and the United States. Cooperative research in the areas of food technology and quality control and standardization offers an opportunity of nutritional improvement of rice by breeding. Cooperative research between Mexico and the U.S. would make possible the growing and evaluation of two generations of rice each year and materially shortening the development time for improved varieties.

e. Improve nutrition of food and feed grains.

Both Mexico and the U.S. are involved in the improvement of the amino acid content and balance of corn even though the expected usage of the improved product may vary considerably in each country. Opportunity exists to similarly improve the nutritive value of sorghum by developing new types with higher digestibility. The development and wide distribution of varieties with greater nutritive value could be greatly enhanced by a broad cooperative effort to develop more efficient breeding methods and new techniques to quickly and economically identify desirable genotypes possessing not only a higher content of essential amino acids but also an improved biological efficiency index. These objectives should be pursued through the exchange of scientific and technical personnel and the development of cooperative projects.

f. Research on range management of arid and semi-arid land.

About 125 million hectares of land in Mexico are designated as arid or semi-arid. Most of this is used as rangeland for grazing cattle. Overgrazing of much of this rangeland for some 400 years has left formerly productive rangeland in greatly deteriorated condition. Much of the area for 250 miles south of the U.S. border contains the same grass and brush species with related problems as are found in Texas, New Mexico, and Arizona. The greatest needs are to eradicate undesirable brush species such as creosotebush and mesquite to encourage development of desirable native grasses. In some areas it may be feasible to investigate methods for reseeding depleted rangeland with desirable species. Also range management systems need to be explored that will economically improve the resource without degrading it further. Native and introduced grasses and shrubs need to be evaluated to determine their adaptation to local conditions and their nutritive qualities.

g. Research on nutritional improvement of forage for improved tropical livestock production.

Tropical livestock management entails growing suitable forage for pasture or for reserve during periods when forage is low in nutritive value or is unavailable. Often during winter months when forage is deficient animals show large weight losses. We need to know how much weight can be lost without endangering survival or impairing reproductive

efficiency. Quality, especially digestible energy content of tropical forage is often low. We need to know how much can animal performance be improved by providing supplemental energy or by improving forage quality through plant breeding or management. What opportunities exist for using by-products of tropical crops (molasses, sugarcane bagasse, fruit pulp, etc.) as forage supplements or as substitutes during periods when grazed forage is deficient? Also what native or introduced forage species are best adapted to specific conditions and can be improved in quality.

h. Weed research as related to the crops of the Lower Rio Grande Valley.

Cereal crops. The export of improved varieties of planting seeds has aided recipients of these advanced strains. One of the major problems is the accompanying weed seed contaminant. An example is the improved wheat varieties from Mexico being introduced into India. Unfortunately weed seeds are also distributed by this means. Joint cooperative research would be of mutual benefit to either country and would do much to improve U.S.-Mexican relations.

Horticultural crops. Presently an informal continuing arrangement exists between Dr. R. M. Menges, U.S. Fruit, Vegetable, Soil & Water Research Laboratory, Weslaco, Texas, and Mr. J. Torrolua Elquezabal, Rio Bravo Experiment Station, Tamaulipas, Mexico, for the exchange of scientific information of mutual interest. The existing informal arrangement could be expanded into a full scale cooperative program in the area of weed research. Such activities would provide greater continuity to solutions of common interest.

i. Research on the chemical and biological control of weeds, and especially narcotic plants.

Currently each potential biological control agent that is under consideration for introduction into the U.S. is reviewed by an Ad hoc Interdepartmental Committee to pass judgment on safety of the introduction and to identify and possibly resolve conflicts of interest. Informal exchanges of information concerning these considerations occur with Canada about our proposed introductions and theirs. We need to establish similar working relations with Mexico.

An effective cooperative integrated research program on control of marihuana between the U.S. and Mexico would be more beneficial than with either country working separately. The development of chemical and biological control practices within the area where the narcotic plant originates would be of more value than working in areas far removed from the source.

Veterinary Sciences Research

1. Exchange of scientists and technicians:

   a. The Animal Health Division maintains a staff in Mexico as a part of its FMD surveillance program. A diagnostic laboratory at Palo Alto, just outside of Mexico City is jointly staffed by Mexican and Animal Health Division personnel. On occasion, personnel from the Palo Alto laboratory (both U.S. and Mexican) have spent time at our Plum Island Animal Disease Laboratory (PIADL) for training in appropriate diagnostic procedures. It is suggested that this exchange be augmented with routine, two-way exchange of scientists between Palo Alto and the PIADL diagnostic investigations unit.

   b. Consideration should be given to the exchange of personnel of the National Animal Parasite Laboratory, Beltsville, and Mexican government laboratories or veterinary schools engaged in research on parasitic diseases of livestock of mutual interest.

2. Joint cooperative research and training projects:

   a. Venezuelan equine encephalomyelitis: At the present time, VSR and Mexican scientists are studying the stability of the attenuated vaccine against this disease by a series of packpassages in susceptible horses. This is a temporary cooperative study that could readily be converted to a longer term cooperative effort which would benefit both countries.

   b. PIADL Foreign Animal Disease Training Course: Consideration might be given to including an appropriate, qualified Mexican representative in one more future courses.

Animal Science Research

Poultry research primarily in the area of avian leucosis involving exchange of scientists. A Mexican scientist, Dr. Garrido, recently spent one year at the East Lansing Laboratory for training. It would be desirable to continue this sort of exchange. In addition, cooperative research projects could be initiated with specific scientists or laboratories in Mexico.

Swine research in the areas of swine nutrition and reproductive physiology. Information on swine production under subtropical and tropical conditions is seriously lacking. This research could involve exchange scientists and joint meetings as well as cooperative research.

Beef, sheep, and dairy research primarily breeding, nutrition, and management research on the performance of cattle in tropical and subtropical climates. The work would include research in breeding to develop optimum procedures for improving the genetic potential of cattle and sheep to produce in adverse environments and practical feeding and management procedures to minimize the effect of adverse environment.

Agricultural Engineering Research

Insect control programs. The screwworm campaign and the VEE campaign so far have been based primarily on U.S. interests. It would be much better if programs could be initiated in which the interests of Mexico were first and into which they would be willing to put resources commensurate with the importance of the problems to Mexico as well as the U.S.

We suggest that at least one Mexican scientist be stationed at College Station, Texas, to work with AE engineer Joe Hollingsworth to learn about area wide insect control problems and possibilities. Also, at least one U.S. engineer should be included in a team of U.S. scientists which would go to Mexico to work with Mexican scientists to determine the potentials and feasibilities of setting up insect control programs which would be of first interest to the government of Mexico. Unless the projects are related to the first interest of Mexico, we doubt that they will be taken seriously by the Mexican government.

Tropical livestock management. The USDA is presently determining the feasibility of tropical livestock research in Puerto Rico, Hawaii, and related mainland universities. We suggest the possibility that there might be a cooperative project on tropical livestock management set up with the Mexican government. Such a project might include teams of animal husbandrymen, engineers, entomologists, economists, and others. Mexico is undoubtedly interested in bettering her livestock production and it may be possible that she will have something to contribute to the livestock industry in the U.S. At least it would be possible to have some sort of a tropical livestock research program, cooperative with the Mexican government, from which information could be fed into the other efforts which are being proposed for Puerto Rico and Hawaii.

Nonchemical pest control by means of parasites and predators. The screwworm program has been mentioned previously. There are other insects which may be controlled by a combination of chemical and insect sterilization programs. There are still others which may possibly be controlled by combinations of parasites, predators, and sterilized insects. Such a program should have considerable interest to the Mexican government inasmuch as cotton was driven out of northern Mexico because of the rapid development of resistance to insecticides by the tobacco (cotton) budworm. Research on these insects could be speeded up in tropical climates as compared to research in the U.S. It is also possible that a related project could be set up on insect movements from Mexico into the U.S. A related project would be that on mass production of parasites and predators as compared to our usual concept of mass production of insects for sterilization.

Soil and Water Conservation Research

Remote sensing. Some past cooperation and proximity of Weslaco to Mexico might make it feasible to constructively engender a cooperative effort to expand our capability in applications in remote sensing.

Soil fertility. The interest in ARS in tropical soils may lead to meaningful cooperation in this area, expanding present work in Puerto Rico, Alabama, and Beltsville.

Marketing and Nutrition Research

Specific areas of cooperation.

1. Control of stored-product insects; non-persistant insecticides and biological and other means of non-chemical control.

2. Increased use of plant proteins.

3. Improving handling, conditioning and storage of agricultural crops.

4. Prevention of general microbiological deterioration.

5. Mycotoxins in food and food products.

6. Packaging and transportation of horticultural crops.

7. Oilseed and protein technology.

8. Technology and engineering information on peanuts.

9. Processing and utilization of agricultural residues.

10. Identification of toxic components in food and feed products.

Potential Locations for Mexican Participants - Technician Exchange Program

A. Item 2D-Alternate Methods of Insect Protection
Mission, Texas - Screwworm
Phoenix, Arizona - Pink Bollworm
Monterey, Mexico - Mexican fruit fly

B. Item 2F - Research on Range Management of Arid and Semi-arid Lands
Las Cruces, New Mexico
Tucson, Arizona

C. Item 2G - Research on Nutritional Improvement of Forage and Improved Tropical Livestock Production
Tifton, Georgia
Rio Piedras, Puerto Rico

D. Item 1A - Exchange of Scientists and Technicians with PIADL Diagnostic Investigations Unit
PIADL, Orient Point, New York

E. Item 2A - Venezuelan Equine Encephalomyelitis
Denver, Colorado

F. Item 2B - PIADL Foreign Animal Disease Training Course
(PIADL, Orient Point, New York (2 weeks)
(NADL, Ames, Iowa

G. Swine Research
Beltsville, Maryland
Fort Reno, Oklahoma (evaluation of breeding stocks)

H. Beef, Sheep and Dairy Research
Beltsville, Maryland - for all three
Clay Center, Nebraska - Beef and sheep
Jeanerette, Louisiana - Beef and dairy (more applied research)

I. Insect Control Problems
College Station, Texas
Gainesville, Florida

J. Tropical Livestock Management
College Station, Texas

K. Non-Chemical Pest Control by Means of Parasites and Predators
Beltsville, Maryland
College Station, Texas
St. Croix, Virgin Islands

L. Remote Sensing
Weslaco, Texas

M. Soil Fertility
Rio Piedras, Puerto Rico
Auburn, Alabama
Beltsville, Maryland

N. Item 1 - Control of Stored Product Insects
Savannah, Georgia
Manhattan, Kansas

Item 2 - Increased Use of Plant Proteins
Peoria, Illinois - soybeans
New Orleans, Louisiana - Cottonseed
Albany, California - alfalfa

Item 3 - Improved Handling, Conditioning and Storage of Agricultural Crops
Ames, Iowa - corn
Albany, California - alfalfa
Tifton, Georgia - forages

Item 6 - Packaging and Transportation of Horticultural Crops
Beltsville, Maryland
Orlando, Florida - trucking & transportation

Item 7 - Oilseed and Protein Technology
Peoria, Illinois - soybeans
New Orleans, Louisiana - cottonseed and peanuts
Albany, California - safflower

Item 10 - Identification of Toxic Components in Food and Feed Products
Wyndmoor, Pennsylvania - potatoes
Peoria, Illinois - soybeans

Would suggest substituting Item 5, Mycotoxins in Food and Feed Products, for Item 10. Have more active programs under Item 5.
Grains - Peoria, Illinois
Cottonseed and Peanuts - New Orleans, Louisiana

Screwworm

May 17, 1972

Col. Charles Barnes
Mail Code DC-5
Manned Spacecraft Center, NASA
Houston, Texas 77058

Dear Colonel Barnes:

Thanks for sending me a draft abstract of the remote sensing proposal. It seems well thought out and offers considerable promise of obtaining the kind of data we feel necessary for the screwworm work.

As you may or may not know, the Agricultural Research Service is undergoing reorganization. As of July 1 all of the ARS Divisions will cease to exist, including the Entomology Research Division and all of its research Branches. The new Agricultural Research Service organization will consist of regions and areas, and Texas will be in the Southern Region. The former Entomology Research Division Director, H C Cox, will be Associate Deputy Administrator of the Southern Region. The former Chief, Fruit Insects Research Branch, Edgar A. Taylor, will be Area Director for all of southern Texas (south of about 28° 30' north latitude), and ARS research in Mexico.

To assure continued cooperative interest in the NASA proposed remote sensing program, we have urged Dr. Taylor to attend your May 24th meeting, and we believe he will be able to attend. We are delighted that Dr. Taylor will receive the southern Texas assignment (he will be stationed at Weslaco) for many reasons. He is familiar with the sterile male technique, having directed programs against several species of fruit flies; he has also been a prime mover in remote sensing studies of the Division. Bill Hart is one of his men at Weslaco, and we hope that Bill will also be able to attend the May 24th meeting.

Sincerely yours,

John A. Fluno
Assistant to the Chief
Insects Affecting Man and
Animals Research Branch

ARS:ENT:JAFluno:mcp

May 17, 1972

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Sincerely yours,

John A. Glass
Assistant to the Chief
Insects Affecting Man and
Animals Research Branch

ARS:ENT:JAFlumo:mcp

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ROUTING SLIP

MAIL CODE	NAME	
	Mr John Fluno	Action
	USDA	Approval
	Beltsville Md	Call Me
		Concurrence
		File
		Information
		Investigate and Advise
		Note and Forward
		Note and Return
		Per Request
		Per Telephone Conversation
		Recommendation
		See Me 5-8-72
		Signature
		Circulate and Destroy

Insects Affecting Man & Animals

C.H.S.

~~E.A.H.~~

J.A.F.

Here's a draft of our proposal. Am clearing an official copy through channels. Would appreciate your comments by telecon.

Am proposing another meeting of the Remote Sensing Working Groups (TASK FORCE) at Mission Tex on 24 May. Hope you will be there.

NAME	TEL. NO. *(or code)* & EXT.
CM Barnes	(713) 483 5406
CODE *(or other designation)* DD 121	**DATE** 2 May 72

NASA FORM 26 APR 69 PREVIOUS EDITIONS MAY BE USED

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DRAFT

ABSTRACT

A PROPOSAL FOR A FEASIBILITY TEST OF THE USE OF REMOTE SENSING IN SCREWWORM ERADICATION

This document contains a National Aeronautics and Space Administration (NASA) proposal concerning the use of remote sensing technology to support the U. S. Department of Agriculture (USDA) in its program of eradication of the screwworm fly. The current USDA program is directed at preventing reinfestation of the United States, which was cleared of overwintering populations of the fly in 1966. A future planned program includes fly eradication in a large part of northern Mexico.

As a prelude to the program, the NASA proposes to examine in concert with USDA, the feasibility of using remote sensing in the eradication effort. Studies would be limited to a defined test site within Mexico. Remote sensing would provide detailed environmental data of the test site. Simultaneous ground studies would relate insect ecology to collected sensor data. An analysis would determine the usefulness of remote sensors for detection of environmental factors conducive to the growth of insect populations. If test site studies are successful, such information could lead to a cost effective climatology system required for the major screwworm eradication effort. The basic science developed could lead to useful application in eradication of other insect pests which have similar morphological characteristics as the screwworm fly.

A PROPOSAL FOR A FEASIBILITY TEST OF THE USE OF REMOTE SENSING IN SCREWWORM ERADICATION

1. General

a. The screwworm fly has infested the tropical and temperate zones of North and South America and caused serious losses to livestock and wild animal life for over 125 years. The infested area extended from South Central Argentina and Chile as far north as Nebraska. The insect causes losses to warm blood animals by laying eggs in any open wound, no matter how small. The eggs hatch into larvae which eat deeply into the wound. If not detected and treated, the infected animal may die in a few days. Even after treatment the animal may be stunted, make slow weight gains, and be more susceptible to infection. The end result is increased cost of production, reduced income to ranchers and dairymen. In Latin America an additional problem is the simple fact that the result is a loss of an irreplaceable protein resource which is vital to human health.

b. Detection and treatment remained the only remedy to the problem until the late 1930s when a theory concerning the use of sexually sterile flies was developed. It was based on the fact that the female fly breeds only once in the life cycle. It was therefore theorized that if sterile male flies could be produced and seeded in the infested area for several generations, the fly population would disappear.

c. The theory was of minor practical value until 1951 when Cobalt-60 radiation sources were developed which provided a practical method of irradiating the larvae to produce sterile flies.

2. The Eradication Program in the United States

a. The eradication program in the United States was developed and carried out by the U. S. Department of Agriculture. The first area to be attacked was the Southeastern United States. Sterile flies were produced and distributed in the area by aerial seeding carried out by light aircraft. The problem was eliminated in the Southeast by 1959.

b. A similar program was launched in the Southwest United States in 1962. Sterile flies were produced at a new production facility at Moore Field, Mission, Texas, which was capable of producing 150 million flies per week. By 1966 the screwworm fly was eliminated from the United States.

c. The total cost of the eradication project in the United States was approximately 25 million dollars. It is estimated that the savings to the cattle and dairy industries amount to 120 million dollars annually.

3. The United States Barrier Program (Figure 1)

The elimination of the fly from the United States required a system for insuring against reinfestation from Latin America. To accomplish this task the Department of Agriculture together with the Mexican Government has established a barrier along the United States/Mexico border

extending into Mexico in some depth. In this barrier area sterile flies are continually seeded and ground checks made periodically by agents of a joint Mexican-American commission for the control of screwworms and by residents of the area to detect evidence of reinfestation. "Hot spots" are then heavily seeded to restrict the spread of the insect and to eliminate its source. This program is supported by the sterile fly production plant at Mission, Texas, and by aircraft assigned to the Department of Agriculture. The cost of the barrier is five million dollars annually and it must be maintained indefinitely unless Mexico is cleared.

4. The Mexico Eradication Program

a. A Mexico/United States survey to determine the feasibility of a screwworm eradication program throughout Mexico has been completed. A favorable report has resulted in a detailed program prepared by the United States Department of Agriculture. The project is proposed as an item in the Department's FY 1973 budget. It is estimated that the program will require four years, with the first year devoted to construction of a new production plant in Southern Mexico or equipping a facility aboard a ship. Seeding operations will then continue for two years, with the fourth year devoted to assessing results. The two year seeding period may be reduced considerably if techniques currently under study prove successful.

b. Once Mexico is declared free of the fly the current (United States/Mexico border) barrier will be suspended and a new barrier activated in Southern Mexico.

5. Use of Remote Sensing

a. General

During the past few years a program has been underway to develop earth survey techniques utilizing remote sensing from aircraft and from spacecraft. Resources which have been surveyed in this manner include definition of geologically important areas, coastal and estuarine areas, soils and soil moisture, crops, timber, land use, watersheds, sea state, transportation networks, etc.

b. What is Remote Sensing?

Remote sensing may be thought of as the gathering of information without actual contact with the object or area being investigated. The earth observations instrumentation which gather such information take advantage of the physical principle that all materials radiate or reflect electromagnetic energy and the radiant spectrum is unique for each material making it identifiable. Spectral regions which have received primary attention for earth resources work include the ultraviolet, visible, infrared, and microwave. Advanced photographic techniques are emphasized in the visible range; radiometers, spectrometers, and multispectral

scanners in the ultraviolet, infrared; passive radiometers, scatterometers and side-looking imaging radars in the microwave region. Data accumulated from these sources indeed give the scientific investigator "new eyes" in observing man's environment. While these new methods are in their infancy when used in applications to earth's problems, they are proving cost beneficial in several instances.

c. Remote Sensing in Public Health Application to Insects

During recent months considerable effort has gone into a new program of the use of remote sensing to define environmental conditions which contribute to the degradation of human and animal health. A major subject of study has been that of insects and arthropods important to man's well being. This has included one small project to study the ecology of the screwworm fly as a model for all pupating insects. From this preliminary survey it is believed that remote sensing can contribute materially toward understanding environmental conditions where this insect thrives. However, it is also evident that insufficient scientific information is available concerning the total environmental requirements for this particular insect. While some data is available in the literature such as optimum soil temperature desired by the pupal stage, a comprehensive ecological model must be further developed. For this reason it is believed that remote sensing and appropriate ground studies in a small test area is mandatory prior to initiating aircraft operations in support of a major eradication effort.

6. Climatology and the Screwworm Fly

a. Background

The USDA proposal to eradicate the screwworm fly from Northern Mexico is an ambitious project. However, in the southern and southwestern United States, it has been shown that by utilizing aerial drop technique vast areas can be covered quickly and liberated from this insect pest. In these eradication campaigns considerable gain was acquired by taking advantage of weather and climatological conditions which limited and defined more precisely the affected zone. In the first Florida campaign an unusually severe winter killed numerous insects and suggested that the program be initiated some months previous to planned sterile insect releases. In Mexico, weather conditions should be more stable. Instead of temperatures increasing in the spring latitudinally from south to north as in the southern United States, it is affected primarily by changes in altitude. The terrain varies from the tropical lowlands to a central plateau and extends to numerous high mountain peaks. Several major canyons and river valleys complicate the climatology as their waters flow from the central highlands to the coast.

Another factor which influences the insect life cycle concerns the predominance of rainy and dry seasons in much of Mexico. The eradication campaign planners will undoubtedly take advantage of these seasonal ground moisture conditions which may preclude the development of insect pupae.

When working in the United States, planners received data from numerous weather stations available from the Weather Service. In addition, there were reports of soil moisture and other factors relating to crop production routinely reported to USDA. Within Mexico, the number of weather stations is materially reduced and climatological data reported from other sources is minimal.

From the above discussion it is reasonable to assume that additional detailed climatological data throughout Mexico is not only desirable but necessary to improve the cost effectiveness of the eradication program. Since it appears unlikely that sufficient detailed field reports will be available for planning purposes it will be necessary to either increase the number of observation points or to use some other method of gaining such information. Remote sensing technology might logically provide this data in a convenient format for operational use.

7. NASA Proposal

a. Test Site

It is proposed that NASA technology concerning the use of remote sensing be utilized to determine local climatology in a test site within Mexico. The test site would be selected for its varied altitude and environmental conditions which are conducive to the growth and study of the screwworm fly. It will be situated south of the current screwworm barrier drop zone to preclude the effects of sterile fly release on the naturally occurring population.

The USDA (Mexico City Office) has proposed a test site somewhere along Highway 86 between Ciudad Valles, Tps., and Rio Verde, S.L.P. (Figure 2). Final selection can be accomplished in the near future.

It is proposed that NASA aircraft overfly the test site prior to initiating detailed ground studies on the test insect. Additional overflights and collection of remotely sensed data would be undertaken at appropriate intervals as determined by the project manager and based primarily on data returned from the entomological and/or climatological ground truth team. Final analysis of test site results will determine the feasibility of its use in the major screwworm eradication campaign.

It is proposed that the test site also be the subject of ad hoc investigation by means of the Earth Resources Technology Satellite (ERTS). Staff members of the Health Applications Office, NASA, MSC, will be responsible for review of ERTS coverage of Mexico as it becomes available. It is anticipated that ERTS data will provide a fair amount of climatological information useful in the overall evaluation. Since the screwworm fly is a vigorous insect ranging over several miles in the course of his lifetime it is possible that ERTS material may be of sufficient resolution that aircraft data will not be required or its use may be materially curtailed.

b. Remote Sensing Instrumentation

The basic question to be answered if remote sensors are to be used is what are the highly reliable parameters that can be observed which relate to the environment of the screwworm. From previous experience, the factors that strongly influence the screwworm fly population are soil moisture, temperature, and vegetative cover. These items may be influenced by latitude and, in Mexico, variations may be affected primarily by altitude.

The basic types of aircraft remote sensing instruments to be used for measuring and recording the soil moisture, temperature, and vegetative cover are summarized in Figure 3 and spacecraft instrumentation in Figure 4.

c. General Working Arrangements

(1) A U.S. inter-agency working group (Figure 5) will be continued to complete technical details of the proposed joint effort to determine the feasibility of the use of remote sensing to assist in eradication of the screwworm fly.

(2) A general plan for organization is proposed in Figures 6 and 7.

(3) The Office of International Affairs, Headquarters NASA will coordinate with the Department of Agriculture and State to lay the necessary ground work for a cooperative international program between Mexico and the U.S. as described previously. They will attempt to expand current arrangements of the joint Mexican-American Commission for the Control of Foot and Mouth Disease and the Screwworm Fly (Figure 7) to include provisions for remote sensing as an adjunct effort. Due to the technical expertise in the U.S. Earth Observations Program it is expedient to assume that U.S. aircraft, spacecraft, and data processing facilities will be utilized in the test program. In this case it is highly desirable that appropriately trained Mexican nationals be invited to participate in total technical management of the remote sensing program. This might include entomology experts from the research staff of the Secretaria de Agricultura as well as remote sensing staff from the Exterior Space Commission. The Mexican Defense Ministry would necessarily become involved in the case of aircraft overflight. Working space for a small contingent can be arranged at the Manned Spacecraft Center.

(4) Upon completion of general agreements between the two countries there will be formed a Mexican-American Coordination Group (Figure 6) to promote harmony in the day to day operations of the program, to favorable publicize the results of goals achieved in the joint effort, and to contribute toward further programs between the two nations as appropriate.

(5) The day to day operational management of the remote sensing portion of the test site program is conceived primarily as a function of the Health Applications Office, (Health Services Division, Life Sciences Directorate, Manned Spacecraft Center, NASA) located in Houston, Texas.

This office is colocated within the Earth Observations Division, (Science and Applications Directorate) at the same center. From this position, health related functional programs are conducted and supported by the entire staff including aircraft and data processing facilities. Appropriate staff members of the U.S. and Mexican governments should be invited to participate in routine management of field operations and analysis as members of the Remote Sensing Operations Team. In this way the necessary interface can be maintained between cognizant agencies. If resident, on site participation cannot be arranged, regular meetings must be held to coordinate the various aspects of the program.

(6) NASA proposes to furnish jointly with the Mexican space agency through contractor support arrangement, some technical and scientific staff to complement the research effort within the test site (Figure 6). Specifically it proposes to provide the expertise required to accumulate "ground truth" information necessary to understand data gathered by aircraft or spacecraft. Operation of the test site would be the responsibility of the joint Mexican-American Campaign for Control of the Screwworm Fly which is now in existence as a sub effort of the Mexican American Commission for the Control of Foot and Mouth Disease. Further details on organization, personnel, and support will be resolved in meetings of the interagency task force and by agreement with the joint Commission.

d. Costs

(1) It is proposed that the costs of the feasibility tests be the joint responsibility of the affected agencies of both governments. Operation of the ground test site could be adjucated the same way as that currently being conducted by the joint Campaign for the Control of the Screwworm Fly. NASA (MSC) has already budgeted for some technical assistance to ground truth support for the test site.

(2) It is proposed that if U.S. aircraft and/or spacecraft are used, costs supporting the feasibility test operations be borne by NASA as well as data reduction and processing costs.

(3) The Mexican government should be asked to provide staff support and travel funds for those members assigned to work at the Houston project office. NASA can supply necessary work space and office supplies to support routine work requirements.

(4) Unanticipated costs are expected to be shared on a 50 - 50 basis or approved by participating agencies of the governments concerned.

(5) USDA is encouraged to detail sufficient technical staff to NASA (MSC) Houston to support routine operations of the Remote Sensing Operations Team and the test site within Mexico. Office space and routine support can be arranged within the Health Applications Office.

THE CURRENT U.S./MEXICAN BORDER BARRIER

FIGURE 1

FIGURE 2
PROPOSED TEST SITE

FIGURE 3.

AIRCRAFT INSTRUMENTATION OF VALUE IN SCREWWORM RESEARCH

REMOTE SENSOR SYSTEM	MEASUREMENT/DISCIPLINE
PHOTOGRAPHIC	
COLOR PHOTOGRAPHY	BASE MAPPING
COLOR IR PHOTOGRAPHY	VEGETATION ∘ SOIL MOISTURE ∘ SOIL TYPE (POROSITY)
BLACK AND WHITE STEREO PHOTOGRAPHY	TOPOGRAPHY (FINE)
MULTI-SPECTRAL PHOTOGRAPHY	VEGETATION
INFRARED	
IR THERMAL SCANNER	TEMPERATURE GRADIENTS ∘ SOIL MOISTURE ∘ SOIL TYPE (POROSITY)
PRECISION RADIATION THERMOMETER	TEMPERATURE
MICROWAVE	
RADAR	TOPOGRAPHY (ROUGH)
RADAR ALTIMETER	ALTITUDE
PASSIVE MICROWAVE	SOIL MOISTURE

MUCH INFORMATION IS INFERRED FROM THE DIRECT MEASUREMENT. FOR EXAMPLE, KNOWING THE TYPE VEGETATION PRESENT, THE SOIL TYPE IS KNOWN FROM THE REQUIREMENTS TO SUPPORT SUCH PLANTS, THE SOIL MOISTURE IS PARTIALLY INFERRED BY ASSESSING PLANT HEALTH OR STRESS.

FIGURE 4.

ERTS INSTRUMENTATION OF VALUE IN SCREWWORM ENVIRONMENT RESEARCH

RETURN BEAM VIDICON (RBV)

No. 1	.475	.575
No. 2	.580	.680
No. 3	.690	.830

MULTISPECTRAL SCANNER (MSS)

CHANNEL 1	.5	.6	
CHANNEL 2	.6	.7	
CHANNEL 3	.7	.8	
CHANNEL 4	.8	1.1	
CHANNEL 5	10.4	12.6	(ERTS B ONLY)

(INSTANTANEOUS FIELD OF VIEW 260 FT. X 260 FT.)

FIGURE 5.

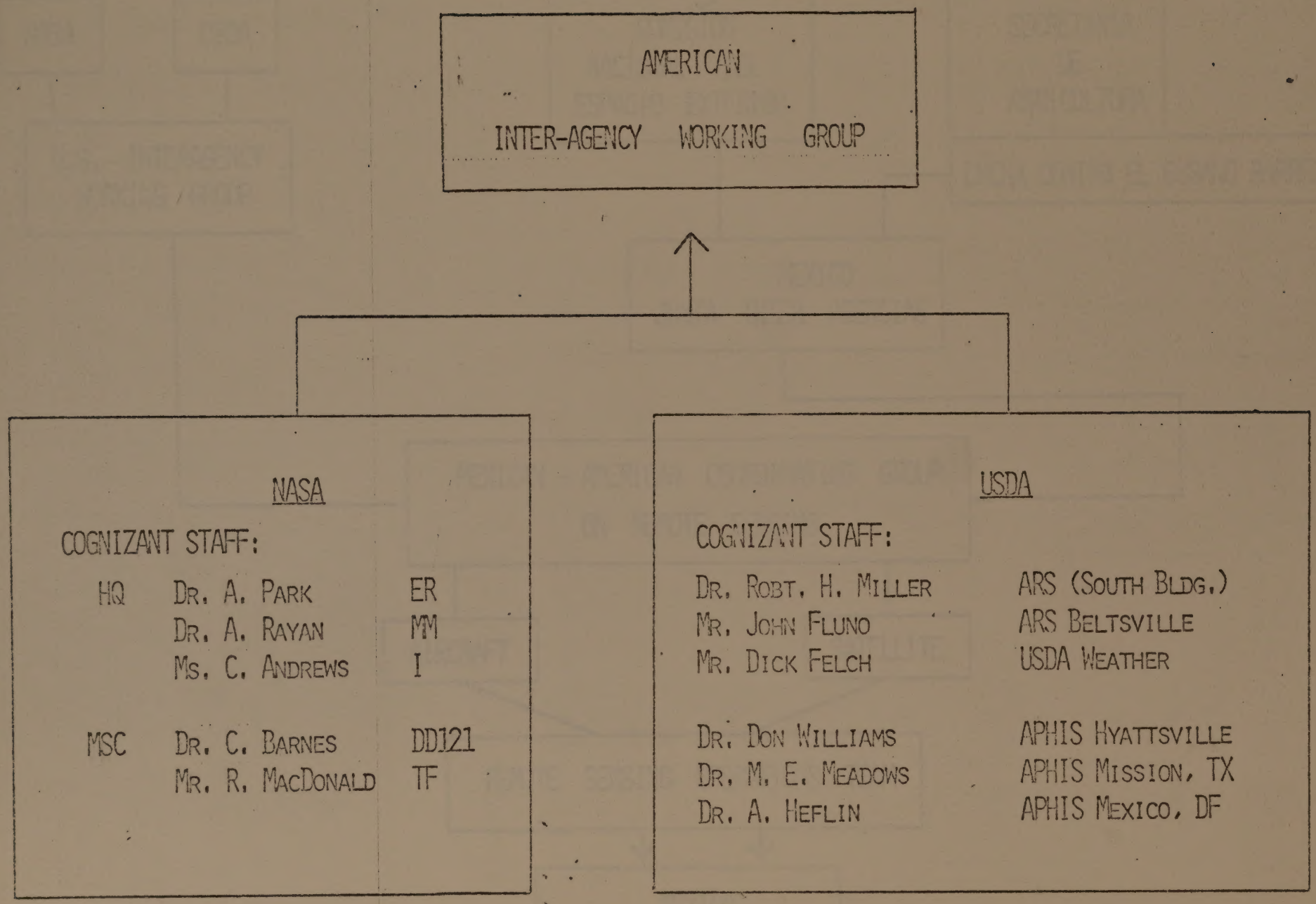

AMERICAN
INTER-AGENCY WORKING GROUP
NASA
COGNIZANT STAFF:
HQ DR. A. PARK ER
DR. A. RAYAN MM
MS. C. ANDREWS I
MSC DR. C. BARNES DD121
MR. R. MACDONALD TF
USDA
COGNIZANT STAFF:
DR. ROBT. H. MILLER ARS (SOUTH BLDG.)
MR. JOHN FLUNO ARS BELTSVILLE
MR. DICK FELCH USDA WEATHER
DR. DON WILLIAMS APHIS HYATTSVILLE
DR. M. E. MEADOWS APHIS MISSION, TX
DR. A. HEFLIN APHIS MEXICO, DF

FIGURE 6.

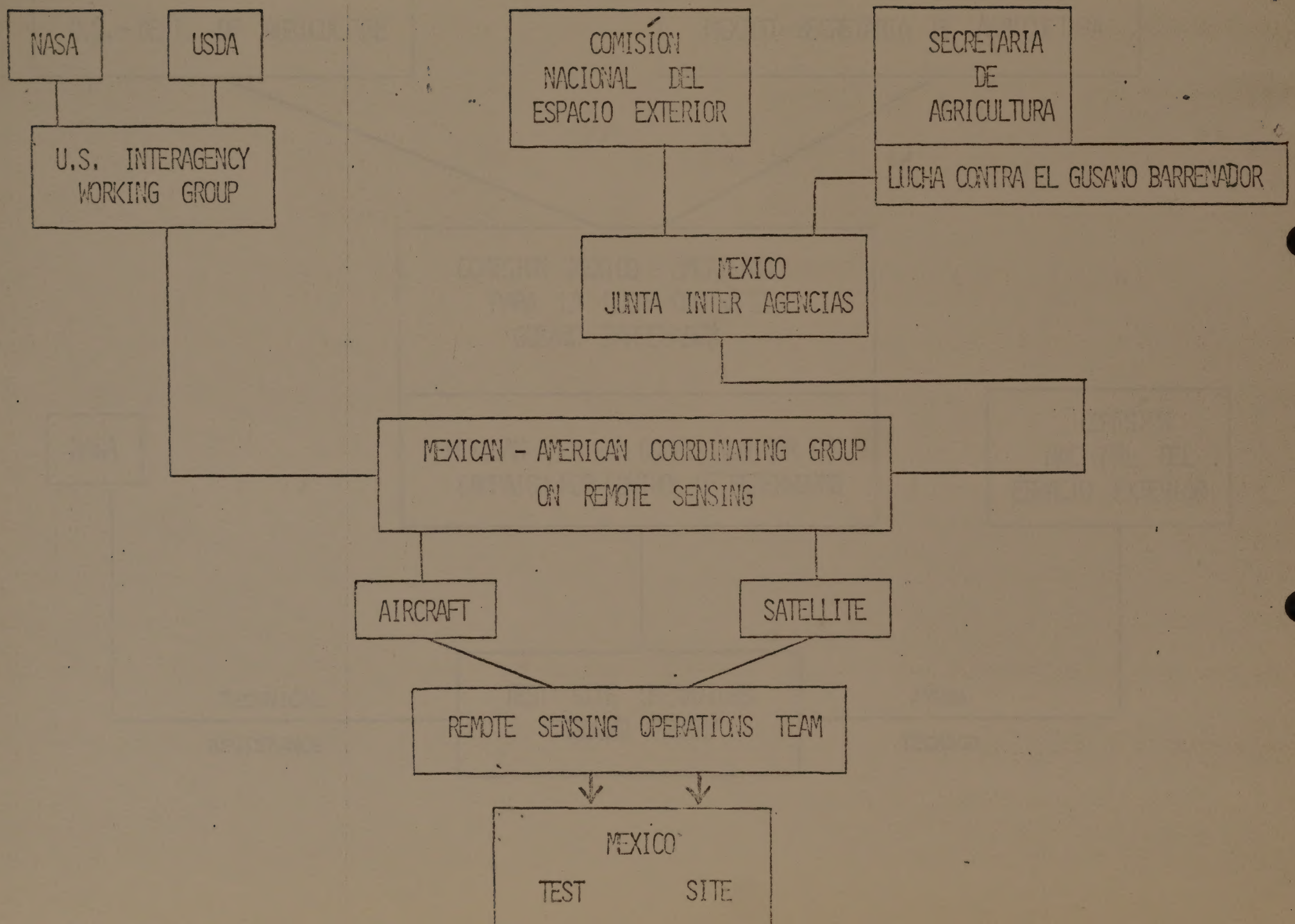
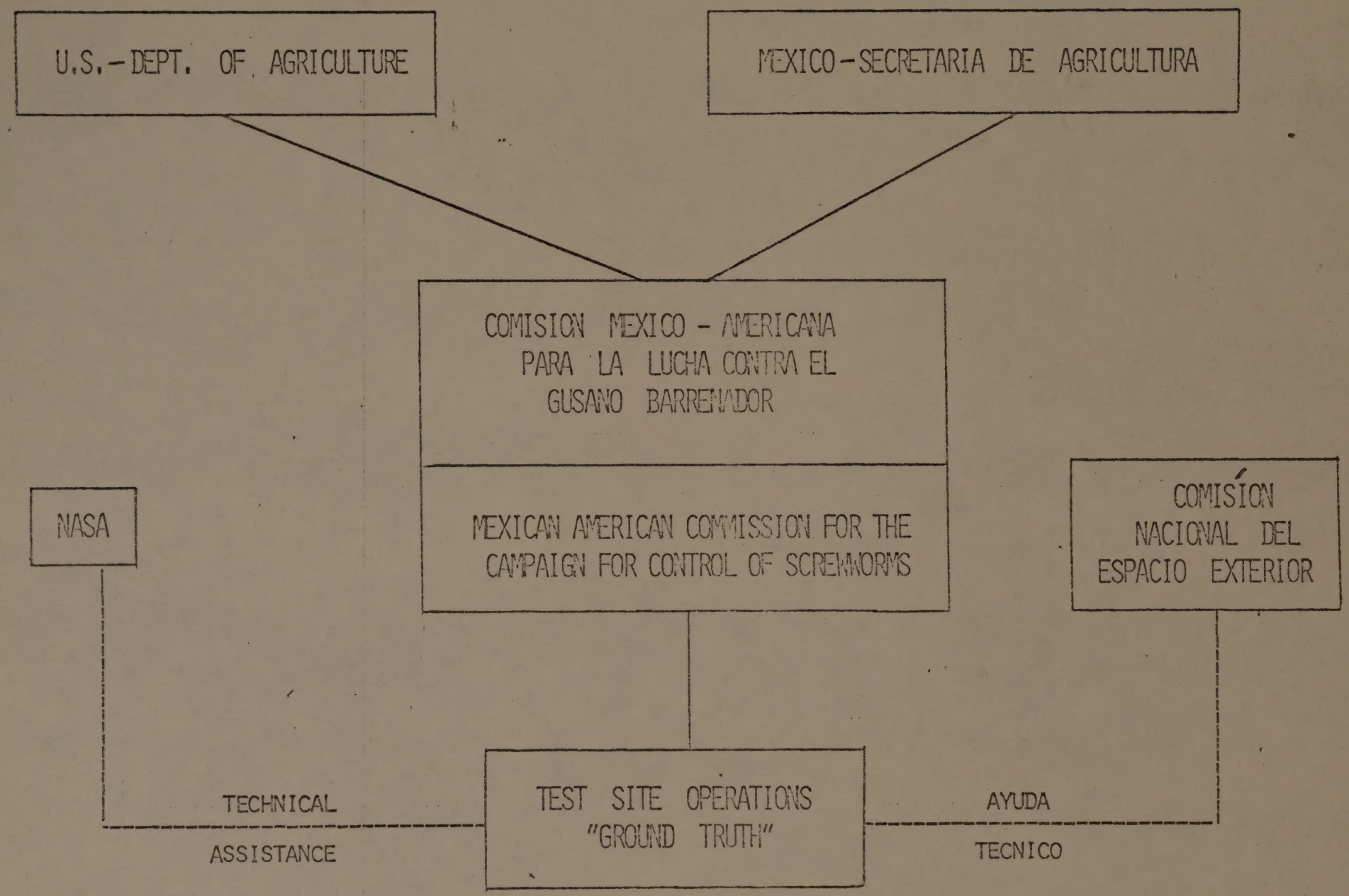

NASA
USDA
U.S. INTERAGENCY WORKING GROUP
COMISIÓN NACIONAL DEL ESPACIO EXTERIOR
SECRETARIA DE AGRICULTURA
LUCHA CONTRA EL GUSANO BARRENADOR
MEXICO JUNTA INTER AGENCIAS
MEXICAN - AMERICAN COORDINATING GROUP ON REMOTE SENSING
AIRCRAFT
SATELLITE
REMOTE SENSING OPERATIONS TEAM
MEXICO TEST SITE

FIGURE 7.


U.S.-DEPT. OF AGRICULTURE
MEXICO-SECRETARIA DE AGRICULTURA
COMISION MEXICO - AMERICANA PARA LA LUCHA CONTRA EL GUSANO BARRENADOR
MEXICAN AMERICAN COMMISSION FOR THE CAMPAIGN FOR CONTROL OF SCREWWORMS
NASA
COMISIÓN NACIONAL DEL ESPACIO EXTERIOR
TECHNICAL ASSISTANCE
TEST SITE OPERATIONS "GROUND TRUTH"
AYUDA TECNICO

NASA-USDA REMOTE SENSING SCREWWORM ERADICATION CONFERENCE (PROPOSAL BY NASA)

Conference Participants: May 24, 1972

Dr. Marco A. Villaseñor, S. A. G.	Mexico, D. F.
Sr. Salvador Garcia Davila, S. A. G.	Monterrey, N. L.
Dr. D. I. Werring, APHIS	Mexico, D. F.
Dr. Floyd E. Smith, APHIS	Mexico, D. F.
Thomas B. Fisher, APHIS	Monterrey, N. L.
C. M. Barnes, NASA, NSC, Chairman	Houston, Texas
Alex B. Thiermann, DVM, Lockheed/NASA	Houston, Texas
Carl S. Hacker, Univ. Texas/School Pub. Health	Houston, Texas
John E. Scanlon, Univ. Texas/School Pub. Health	Houston, Texas
J. L. Hourrigan, APHIS, USDA	Hyattsville, Maryland
Don Williams, APHIS, USDA	Hyattsville, Maryland
M. E. Meadows, Jr., APHIS	Mission, Texas
R. C. Bushland, ARS	Fargo, North Dakota
A. H. Baumhover, ARS	Oxford, North Carolina
Robert H. Miller, USDA, ARS, OA	Washington, D. C.
Sammy J. Ingle, USDA, ARS	Weslaco, Texas
Michael René Davis, USDA, ARS	Weslaco, Texas

DR. CRISTAL-ENT.

PROPOSAL NOT OFFICIALLY APPROVED AS YET BY NASA HQ. CONFEREES IN GENERAL AGREEMENT THAT IF REMOTE SENSING CAN ASSIST IN A "MORE EFFECTIVE" SCREWWORM ERADICATION PROGRAM, THEN LET'S GET GOING. HOWEVER, AFTER PROS AND CONS WERE DELIBERATED AT LENGTH, NOTHING INTRINSICALLY WAS SETTLED. TEST SITE LOCATION(S) IN MEXICO NOT FIRM. NASA A/C AVAILABILITY QUESTIONABLE. TYPE(S) OF "GROUND TRUTH" NEEDED, AND WHY, NOT RESOLVED. NO OFFICIAL COMMITMENT BY MEXICO WAS ESTABLISHED. THE QUESTION OF HOW MUCH ALL CONCERNED AGENCIES WOULD BE WILLING TO COOPERATE WAS NOT RESOLVED.

THE PROPOSED PROGRAM IS STILL NEBULOUS.

NASA-USDA REMOTE SENSING SCREWWORM ERADICATION CONFERENCE (PROPOSAL BY NASA)

Conference Participants: May 24, 1972

Dr. Marco A. Villaseñor, S. A. G.	Mexico, D. F.
Sr. Salvador Garcia Davila, S. A. G.	Monterrey, N. L.
Dr. D. I. Werring, APHIS	Mexico, D. F.
Dr. Floyd E. Smith, APHIS	Mexico, D. F.
Thomas B. Fisher, APHIS	Monterrey, N. L.
C. M. Barnes, NASA, NSC, Chairman	Houston, Texas
Alex B. Thiermann, DVM, Lockheed/NASA	Houston, Texas
Carl S. Hacker, Univ. Texas/School Pub. Health	Houston, Texas
John E. Scanlon, Univ. Texas/School Pub. Health	Houston, Texas
J. L. Hourrigan, APHIS, USDA	Hyattsville, Maryland
Don Williams, APHIS, USDA	Hyattsville, Maryland
M. E. Meadows, Jr., APHIS	Mission, Texas
R. C. Bushland, ARS	Fargo, North Dakota
A. H. Baumhover, ARS	Oxford, North Carolina
Robert H. Miller, USDA, ARS, OA	Washington, D. C.
Sammy J. Ingle, USDA, ARS	Weslaco, Texas
Michael René Davis, USDA, ARS	Weslaco, Texas
DR. CRISTAL-ENT.	

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THE PROPOSED PROGRAM IS STILL NEBULOUS.

U.S. DEPARTMENT OF AGRICULTURE

REFERENCE SLIP

DATE 6/1

TO

Mr. Carlson

- [ ] ACTION
- [ ] APPROVAL
- [ ] AS REQUESTED
- [ ] FOR COMMENT
- [ ] FOR INFORMATION
- [ ] INITIALS
- [ ] NOTE AND FILE
- [ ] NOTE AND RETURN
- [ ] PER PHONE CALL
- [ ] RECOMMENDATION
- [ ] REPLY FOR SIGNATURE OF
- [ ] RETURNED
- [ ] SEE ME
- [ ] YOUR SIGNATURE

REMARKS Keep an eye on this program. Feel APHIS out and Bushland, too, to see if this is something that really needs to be pursued or is it a NASA attempt at sexy publicity.

FROM

6/1/15/18 TWE

GPO : 1964 OF—742-059

FORM AD-514 (8-64)

U.S. DEPARTMENT OF AGRICULTURE

REFERENCE SLIP

DATE 6/1

TO Mr. Carlson

- [ ] ACTION
- [ ] NOTE AND RETURN
- [ ] APPROVAL
- [ ] PER PHONE CALL
- [ ] AS REQUESTED
- [ ] RECOMMENDATION
- [ ] FOR COMMENT
- [ ] REPLY FOR SIGNATURE OF
- [ ] FOR INFORMATION
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FROM 6/1/15 TWE

GPO : 1964 OF—742-059

FORM AD-514 (8-64)

CHHoffmann
SEJones
JEGilmore
FHSchwartz
Files

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

USDA – ARS
RECEIVED
JUN 12 1972
FARGO, N. DAK.
M & R RES. LAB.

OFFICE OF ADMINISTRATOR

June 8, 1972

Subject: Role of Remote Sensing in Screwworm Eradication

To: R. C. Bushland, Director, Metabolism & Radiation Research Laboratory, Fargo, North Dakota

Transmitted herewith is a copy of a report from Robert H. Miller to Mr. Edminster dealing with the possible use of remote sensing in screwworm eradication.

Mr. Edminster is anxious to get your candid opinion on whether this program should be pursued.

Waldemar Klassen

Waldemar Klassen
Assistant to Deputy Administrator

Enclosure

HCCox
CHHoffman
SEJones
JEGilmore
PHSchwartz
Files

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

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Waldemar Klassen
Assistant to Deputy Administrator

Enclosure

dlr Cy

HCCox
CHHoffmann
SEJones
JEGilmore
PHSchwartz
Files

June 12, 1972

Subject: Role of Remote Sensing in Screwworm Eradication

To: Waldemar Klassen, Assistant to Deputy Administrator
Agricultural Research Service, USDA
Room 320 A
Washington, D. C. 20250

This is in response to your memorandum of June 8 requesting information that you can transmit to Mr. Edminster.

On May 24, the day after the Screwworm Conference at Mission, Dr. Williams of APHIS invited Mr. Baumhover and me to meet with some NASA officials in Dr. Meadows' office at the Mission facility. I had no prior notice of the meeting; so I attended mostly to listen. In the course of the meeting, it developed that the NASA officials wanted to cooperate with the Entomology Research staff at Mission as well as with the Eradication Program officials. Since I was there only as a visitor and could not make agreements for members of the Insects Affecting Man and Animals Branch, I suggested that Dr. Crystal be invited to the meeting.

Dr. Meadows said that Dr. Crystal had been invited several days earlier, but he would again ask him to come. Dr. Crystal came when the meeting was nearly over and did not say much. He told me later that his reticence was at the instruction of the Branch Chief, Dr. Schmidt, who said that ARS representatives from Weslaco would be the official spokesmen. Dr. Miller's postscript to the list of attendants is an accurate summary.

I thought that the meeting brought up an interesting subject. The meeting appeared to be one of a series following earlier ones in the Washington area in which Dr. Williams represented APHIS and Mr. John Fluno of Dr. Schmidt's office represented ENT.

My understanding of the situation was that Dr. C. M. Barnes of NASA had a special interest in the screwworm program since he is a veterinarian and was a former USDA employee associated with Dr. Williams. Compared to USDA organizations with which I am familiar, NASA seems to

be flush with money. It seems that Dr. Barnes had available the facilities of an airplane that would fly at about 30,000 feet with remote sensing equipment to measure the various environmental conditions on the ground. In addition to the environmental data crew, NASA had already on its roster a South American entomologist, fluent in English as well as Spanish, with ecological training, whose services they wished to donate to work with one or more ENT representatives. They wanted a test area selected sufficiently far south of the border in Mexico that eradication activities would not eliminate the native screwworm population. The proposal was that entomologists would study screwworm ecology on the ground in this natural habitat and that simultaneously the remote sensing crew would measure weather conditions and such factors as temperature, humidity, and soil moisture as best they could from the air. Then after observations of several months to a year, they would try to correlate ground and air data to see whether conditions that affected screwworm populations could be adequately appraised with remote sensing equipment.

Dr. Williams pointed out that he was particularly interested in such a cooperative enterprise because Mexico lacks the abundant weather stations so well dispersed over the U.S. (For example, screwworms cannot fly at temperatures below 60°F. Therefore winter drops in the southern United States are not made unless the forecast for the day is for expected highs above 60°F. Also in summer conditions, grid drops should not be made over desert areas where flies cannot escape heat and dessication. Aside from these examples, it is generally recognized that weather conditions which favor lush growth of pasture grasses are also favorable to buildup of screwworm populations. So remote measure of greening in an area like Mexico with relatively scanty reporting could be of value to the screwworm program.)

Our own ENT Division has many pressing studies to make in a Mexican area for research in support of screwworm eradication. Our group has to evaluate various rearing and release techniques; conduct tests on the vigor, mating activities, migration, and survival of sterilized flies; compare new strains; test attractants; etc. My own feeling at the conference was that if I were in charge of those Entomology Research activities, I would welcome the free assistance of a bilingual Latin American entomologist. Since I was not responsible, I could not speak up. However, I urged that Dr. Meadows reinvite Dr. Crystal, who came when the conference was nearly over and then was noncommittal in his remarks.

I do not know how practical the whole setup is. As I mentioned, Dr. Barnes seemed to represent an affluent agency. He brought along with him Dr. Thiermann, a veterinarian employed by Lockheed, a NASA contractor in this regard; he also had accompanying him as staff, Dr. Hacker and

Dr. Scanlon, two entomologists from the University of Texas School of Public Health. He also proposed that if this project were implemented, NASA in Houston would want two representative Mexican officials to stay at their Houston headquarters. He said NASA would give free office space and clerical support but they would expect the Mexican Government to pay the salary of the agricultural and aviation officials, who would be Houston liaison for this screwworm field test. All this seemed a little rich for my blood.

I do believe that Dr. Barnes thinks that his agency can make a real contribution to the eradication program, and he wants to become involved. I do think, though, that he is building up way too much of a bureaucratic empire over this preliminary field test, and I got the impression that the two Mexican officials, who were there only incidentally, having stayed on after the conference on the preceding day, were doubtful of the ability of their country to finance two liaison officers in Houston.

I did not report on this meeting earlier since it came within the province of the Insects Affecting Man and Animals Branch, and Dr. Crystal had been briefed by Dr. Schmidt regarding that Branch's participation.

R. C. Bushland
Director

cc: H C Cox

dlr Cy

HCCox
CHHoffmann
SEJones
JEGilmore
PHSchwartz
Files

June 12, 1972

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R. C. Bushland
Director

cc: H C Cox

6/15

Dr. Schmidt,
I'd like your
comments.

#66

Betty — rough

Insects Affecting
Man & Animals

6-16-72

C.H.S.
R.A.H.
J.A.F.

required for comments by HC 6/16/72

EAT

June 20, 1972

Subject: Role of Remote Sensing in Screwworm Eradication

To: H C Cox, Director

We have been involved in preliminary talks and feasibility planning for possible remote sensing of screwworm habitat with NASA, APHIS and Mexican officials for about 2 years. This is an intriguing and potentially valuable concept that we would like to see explored. It would also be an expensive, time consuming project that we are ill-prepared to support with our present staff and budget. We feel our first obligation is to find answers for the current problems APHIS is experiencing in rearing, release, insect vitality, strain characteristics, etc.

It is true, however, that we place a high priority on developing ecological and biological information on the screwworm in Mexico and it is for this reason that Mr. Gaines Eddy has been asked to focus his attention on some of these problems. It is also the reason we have transferred Mr. Calvin Jones from Lincoln, Nebr., to Mission, Texas. We would welcome any participation by the NASA entomologist. If he is available to work with our people at Mission or on ecological field projects in Mexico, we would be delighted to have him. It is possible that some of the ground oriented information needed for a remote sensing evaluation could be accumulated in this way. The facilities and equipment that NASA could bring into such a project would be fine, but we could not afford to make much of a contribution to the operational costs.

Although we feel Dr. Barnes is sincere in his plans for this project, we do feel he is a promoter type and, at least in part, is looking for something for his staff to do in a waning NASA program period. We agree with Dr. Bushland's comment that Dr. Barnes feels he can make a contribution and wants to become involved; also that Dr. Barnes plans are a bit extensive for a feasibility study.

R. A. Hoffman

R. A. Hoffman, Acting Chief
Insects Affecting Man and Animals
Research Branch

RAHoffman:bw

CHS

June 24, 1971

Subject: Role of Remote Sensing in Pest Control Evaluation

To: R. C. Cox, Director

We have been involved in preliminary calls and feasibility planning for possible remote sensing of economic insects with NASA, USDA and various officials for about 2 years. This is an interesting and potentially valuable concept that we would like to have explored. It would also be expensive, thus considering projects that we are willing to support with our present staff and budget. We feel our first obligation is to find answers for the current problems APHIS is encountering in trapping, release, insect vitality, strain genetics, etc.

It is true, however, that we place a high priority on developing ecological and biological information on the screwworm in Mexico and, for this reason, Mr. Graham Fahy has been asked to issue his attention on some of these problems. It is also the reason we have transferred Dr. Calvin Jones from Illinois, Mexico, to Mission, Texas. We would welcome an introduction by the NASA astrobiologist. If data is available to talk with our people at Mission or on ecological trials projects in Mexico, we would be delighted to have him. It is possible that some of the ground criteria forwarded in weeks for a remote sensing evaluation could be accomplished this way. The facilities and equipment that NASA would bring into such a project would be fine, but we would not afford to make much of a contribution in the operational costs.

Although we feel Dr. Barnes is sincere in his plans for this project, we do feel he is a premature type and, at least in part, is looking for money for this study until to do it a regular NASA program period. We agree with Dr. Graham's comment that Dr. Barnes feels he can make a contribution and wants to become involved. We do not use airborne planes as a data source for a feasibility study.

R. A. Hoffman, Acting Chief
Insects Affecting Man and Animals
Plant Protection Division

RAHoffman:bw

June 20, 1972

Subject: Role of Remote Sensing in Screwworm Eradication

To: H C Cox, Director

We have been involved in preliminary talks and feasibility planning for possible remote sensing of screwworm habitat with NASA, APHIS and Mexican officials for about 2 years. This is an intriguing and potentially valuable concept that we would like to see explored. It would also be an expensive, time consuming project that we are ill-prepared to support with our present staff and budget. We feel our first obligation is to find answers for the current problems APHIS is experiencing in rearing, release, insect vitality, strain characteristics, etc.

It is true, however, that we place a high priority on developing ecological and biological information on the screwworm in Mexico and it is for this reason that Mr. Gaines Eddy has been asked to focus his attention on some of these problems. It is also the reason we have transferred Mr. Calvin Jones from Lincoln, Nebr., to Mission, Texas. We would welcome any participation by the NASA entomologist. If he is available to work with our people at Mission or on ecological field projects in Mexico, we would be delighted to have him. It is possible that some of the ground oriented information needed for a remote sensing evaluation could be accumulated in this way. The facilities and equipment that NASA could bring into such a project would be fine, but we could not afford to make much of a contribution to the operational costs.

Although we feel Dr. Barnes is sincere in his plans for this project, we do feel he is a promoter type and, at least in part, is looking for something for his staff to do in a waning NASA program period. We agree with Dr. Bushland's comment that Dr. Barnes feels he can make a contribution and wants to become involved; also that Dr. Barnes plans are a bit extensive for a feasibility study.

R. A. Hoffman

R. A. Hoffman, Acting Chief
Insects Affecting Man and Animals
Research Branch

RAHoffman:bw

June 30, 1971

Subject: Role of Ames Scientists in Interagency Negotiation

To: [illegible] Gen. Director

We have been involved in preliminary talks and feasibility planning for possible remote sensing of ocean-surface pollution with NASA, ERDA and Indian officials for about 2 years. This is an important, and potentially valuable contribution that we would like to accomplish. It would also be an expensive, time consuming project that we are prepared to support with our present staff and budget. Our first obligation is to find answers for the current problems in accomplishing in counting, release, insect vigility, [illegible] chemical [illegible], etc.

It is true, however, that we place a high priority on developing scientific and clinical information on the ecosystem in hopes that it is for this reason that Dr. Quinn Eddy has been asked to focus his attention on some of these problems. It is also the reason we have transferred the Chief [illegible] from Illinois Univ., to Illinois. Hence, we would welcome any [illegible] by the NASA automobiles. If he is permitted to work with our people at Illinois or on ecological field projects in Indian, we might be able to have him. It is possible that some of the ground or [illegible] information needed for a remote sensing evaluation could be accomplished in this way. The facilities and equipment that NASA could bring into such a project would be [illegible], but we could not afford to make such a contribution in the operational sense.

Although we feel Dr. Barnes is sincere in his plans for [illegible] we do feel he is a prospect that [illegible] at least [illegible] is looking for [illegible] for his staff to do in a weather [illegible] program [illegible]. We agree with Dr. Bugliarello's comments that the Bureau [illegible] can make a contribution and wants to become [illegible] also Dr. Barnes [illegible] are a [illegible] for a feasibility study.

E. A. Wolfson, Acting Chief
Insects Affecting Man and Animals
Research Branch

RAWolfson:bw

EH Taylor
note and return
HCCox
CHHoffmann
SSJones
JEGilmore
PHSchwartz
Files

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
ENTOMOLOGY RESEARCH DIVISION
BELTSVILLE, MARYLAND 20705

June 20, 1972

Subject: Role of Remote Sensing in Screwworm Eradication

To: H C Cox, Director

We have been involved in preliminary talks and feasibility planning for possible remote sensing of screwworm habitat with NASA, APHIS and Mexican officials for about 2 years. This is an intriguing and potentially valuable concept that we would like to see explored. It would also be an expensive, time consuming project that we are ill-prepared to support with our present staff and budget. We feel our first obligation is to find answers for the current problems APHIS is experiencing in rearing, release, insect vitality, strain characteristics, etc.

It is true, however, that we place a high priority on developing ecological and biological information on the screwworm in Mexico and it is for this reason that Mr. Gaines Eddy has been asked to focus his attention on some of these problems. It is also the reason we have transferred Mr. Calvin Jones from Lincoln, Nebr., to Mission, Texas. We would welcome any participation by the NASA entomologist. If he is available to work with our people at Mission or on ecological field projects in Mexico, we would be delighted to have him. It is possible that some of the ground oriented information needed for a remote sensing evaluation could be accumulated in this way. The facilities and equipment that NASA could bring into such a project would be fine, but we could not afford to make much of a contribution to the operational costs.

Although we feel Dr. Barnes is sincere in his plans for this project, we do feel he is a promoter type and, at least in part, is looking for something for his staff to do in a waning NASA program period. We agree with Dr. Bushland's comment that Dr. Barnes feels he can make a contribution and wants to become involved; also that Dr. Barnes plans are a bit extensive for a feasibility study.

R. A. Hoffman

R. A. Hoffman, Acting Chief
Insects Affecting Man and Animals
Research Branch

ABSTRACT

A PROPOSAL FOR A FEASIBILITY TEST OF THE USE OF REMOTE SENSING IN SCREWWORM ERADICATION

This document contains a National Aeronautics and Space Administration (NASA) proposal concerning the use of remote sensing technology to support the U. S. Department of Agriculture (USDA) in its program of eradication of the screwworm fly. The current USDA program is directed at preventing reinfestation of the United States, which was cleared of overwintering populations of the fly in 1966. A future planned program includes fly eradication in a large part of northern Mexico.

As a prelude to the program, the NASA proposes to examine in concert with USDA, the feasibility of using remote sensing in the eradication effort. Studies would be limited to a defined test site within Mexico. Remote sensing would provide detailed environmental data of the test site. Simultaneous ground studies would relate insect ecology to collected sensor data. An analysis would determine the usefulness of remote sensors for detection of environmental factors conducive to the growth of insect populations. If test site studies are successful, such information could lead to a cost effective climatology system required for the major screwworm eradication effort. The basic science developed could lead to useful application in eradication of other insect pests which have similar morphological characteristics as the screwworm fly.

A PROPOSAL FOR A FEASIBILITY TEST OF THE USE OF REMOTE SENSING IN SCREWWORM ERADICATION

1. General

a. The screwworm fly has infested the tropical and temperate zones of North and South America and caused serious losses to livestock and wild animal life for over 125 years. The infested area extended from South Central Argentina and Chile as far north as Nebraska. The insect causes losses to warm blood animals by laying eggs in any open wound, no matter how small. The eggs hatch into larvae which eat deeply into the wound. If not detected and treated, the infected animal may die in a few days. Even after treatment the animal may be stunted, make slow weight gains, and be more susceptible to infection. The end result is increased cost of production, reduced income to ranchers and dairymen. In Latin America an additional problem is the simple fact that the result is a loss of an irreplaceable protein resource which is vital to human health.

b. Detection and treatment remained the only remedy to the problem until the late 1930s when a theory concerning the use of sexually sterile flies was developed. It was based on the fact that the female fly breeds only once in the life cycle. It was therefore theorized that if sterile male flies could be produced and seeded in the infested area for several generations, the fly population would disappear.

c. The theory was of minor practical value until 1951 when Cobalt-60 radiation sources were developed which provided a practical method of irradiating the larvae to produce sterile flies.

2. The Eradication Program in the United States

a. The eradication program in the United States was developed and carried out by the U. S. Department of Agriculture. The first area to be attacked was the Southeastern United States. Sterile flies were produced and distributed in the area by aerial seeding carried out by light aircraft. The problem was eliminated in the Southeast by 1959.

b. A similar program was launched in the Southwest United States in 1962. Sterile flies were produced at a new production facility at Moore Field, Mission, Texas, which was capable of producing 150 million flies per week. By 1966 the screwworm fly was eliminated from the United States.

c. The total cost of the eradication project in the United States was approximately 25 million dollars. It is estimated that the savings to the cattle and dairy industries amount to 120 million dollars annually.

3. The United States Barrier Program (Figure 1)

The elimination of the fly from the United States required a system for insuring against reinfestation from Latin America. To accomplish this task the Department of Agriculture together with the Mexican Government has established a barrier along the United States/Mexico border

extending into Mexico in some depth. In this barrier area sterile flies are continually seeded and ground checks made periodically by agents of a joint Mexican-American commission for the control of screwworms and by residents of the area to detect evidence of reinfestation. "Hot spots" are then heavily seeded to restrict the spread of the insect and to eliminate its source. This program is supported by the sterile fly production plant at Mission, Texas, and by aircraft assigned to the Department of Agriculture. The cost of the barrier is five million dollars annually and it must be maintained indefinitely unless Mexico is cleared.

4. The Mexico Eradication Program

a. A Mexico/United States survey to determine the feasibility of a screwworm eradication program throughout Mexico has been completed. A favorable report has resulted in a detailed program prepared by the United States Department of Agriculture. The project is proposed as an item in the Department's FY 1973 budget. It is estimated that the program will require four years, with the first year devoted to construction of a new production plant in Southern Mexico or equipping a facility aboard a ship. Seeding operations will then continue for two years, with the fourth year devoted to assessing results. The two year seeding period may be reduced considerably if techniques currently under study prove successful.

b. Once Mexico is declared free of the fly the current (United States/ Mexico border) barrier will be suspended and a new barrier activated in Southern Mexico.

5. Use of Remote Sensing

a. General

During the past few years a program has been underway to develop earth survey techniques utilizing remote sensing from aircraft and from spacecraft. Resources which have been surveyed in this manner include definition of geologically important areas, coastal and estuarine areas, soils and soil moisture, crops, timber, land use, watersheds, sea state, transportation networks, etc.

b. What is Remote Sensing?

Remote sensing may be thought of as the gathering of information without actual contact with the object or area being investigated. The earth observations instrumentation which gather such information take advantage of the physical principle that all materials radiate or reflect electromagnetic energy and the radiant spectrum is unique for each material making it identifiable. Spectral regions which have received primary attention for earth resources work include the ultraviolet, visible, infrared, and microwave. Advanced photographic techniques are emphasized in the visible range; radiometers, spectrometers, and multispectral

scanners in the ultraviolet, infrared; passive radiometers, scatterometers and side-looking imaging radars in the microwave region. Data accumulated from these sources indeed give the scientific investigator "new eyes" in observing man's environment. While these new methods are in their infancy when used in applications to earth's problems, they are proving cost beneficial in several instances.

c. Remote Sensing in Public Health Application to Insects

During recent months considerable effort has gone into a new program of the use of remote sensing to define environmental conditions which contribute to the degradation of human and animal health. A major subject of study has been that of insects and arthropods important to man's well being. This has included one small project to study the ecology of the screwworm fly as a model for all pupating insects. From this preliminary survey it is believed that remote sensing can contribute materially toward understanding environmental conditions where this insect thrives. However, it is also evident that insufficient scientific information is available concerning the total environmental requirements for this particular insect. While some data is available in the literature such as optimum soil temperature desired by the pupal stage, a comprehensive ecological model must be further developed. For this reason it is believed that remote sensing and appropriate ground studies in a small test area is mandatory prior to initiating aircraft operations in support of a major eradication effort.

6. Climatology and the Screwworm Fly

a. Background

The USDA proposal to eradicate the screwworm fly from Northern Mexico is an ambitious project. However, in the southern and southwestern United States, it has been shown that by utilizing aerial drop technique vast areas can be covered quickly and liberated from this insect pest. In these eradication campaigns considerable gain was acquired by taking advantage of weather and climatological conditions which limited and defined more precisely the affected zone. In the first Florida campaign an unusually severe winter killed numerous insects and suggested that the program be initiated some months previous to planned sterile insect releases. In Mexico, weather conditions should be more stable. Instead of temperatures increasing in the spring latitudinally from south to north as in the southern United States, it is affected primarily by changes in altitude. the terrain varies from the tropical lowlands to a central plateau and extends to numerous high mountain peaks. Several major canyons and river valleys complicate the climatology as their waters flow from the central highlands to the coast.

Another factor which influences the insect life cycle concerns the predominance of rainy and dry seasons in much of Mexico. The eradication campaign planners will undoubtedly take advantage of these seasonal ground moisture conditions which may preclude the development of insect pupae.

When working in the United States, planners received data from numerous weather stations available from the Weather Service. In addition, there were reports of soil moisture and other factors relating to crop production routinely reported to USDA. Within Mexico, the number of weather stations is materially reduced and climatological data reported from other sources is minimal.

From the above discussion it is reasonable to assume that additional detailed climatological data throughout Mexico is not only desirable but necessary to improve the cost effectiveness of the eradication program. Since it appears unlikely that sufficient detailed field reports will be available for planning purposes it will be necessary to either increase the number of observation points or to use some other method of gaining such information. Remote sensing technology might logically provide this data in a convenient format for operational use.

7. NASA Proposal

a. Test Site

It is proposed that NASA technology concerning the use of remote sensing be utilized to determine local climatology in a test site within Mexico. The test site would be selected for its varied altitude and environmental conditions which are conducive to the growth and study of the screwworm fly. It will be situated south of the current screwworm barrier drop zone to preclude the effects of sterile fly release on the naturally occurring population.

The USDA (Mexico City Office) has proposed a test site somewhere along Highway 86 between Ciudad Valles, Tps., and Rio Verde, S.L.P. (Figure 2). Final selection can be accomplished in the near future.

It is proposed that NASA aircraft overfly the test site prior to initiating detailed ground studies on the test insect. Additional overflights and collection of remotely sensed data would be undertaken at appropriate intervals as determined by the project manager and based primarily on data returned from the entomological and/or climatological ground truth team. Final analysis of test site results will determine the feasibility of its use in the major screwworm eradication campaign.

It is proposed that the test site also be the subject of ad hoc investigation by means of the Earth Resources Technology Satellite (ERTS). Staff members of the Health Applications Office, NASA, MSC, will be responsible for review of ERTS coverage of Mexico as it becomes available. It is anticipated that ERTS data will provide a fair amount of climatological information useful in the overall evaluation. Since the screwworm fly is a vigorous insect ranging over several miles in the course of his lifetime it is possible that ERTS material may be of sufficient resolution that aircraft data will not be required or its use may be materially curtailed.

b. Remote Sensing Instrumentation

The basic question to be answered if remote sensors are to be used is what are the highly reliable parameters that can be observed which relate to the environment of the screwworm. From previous experience, the factors that strongly influence the screwworm fly population are soil moisture, temperature, and vegetative cover. These items may be influenced by latitude and, in Mexico, variations may be affected primarily by altitude.

The basic types of aircraft remote sensing instruments to be used for measuring and recording the soil moisture, temperature, and vegetative cover are summarized in Figure 3 and spacecraft instrumentation in Figure 4.

c. General Working Arrangements

(1) A U.S. inter-agency working group (Figure 5) will be continued to complete technical details of the proposed joint effort to determine the feasibility of the use of remote sensing to assist in eradication of the screwworm fly.

(2) A general plan for organization is proposed in Figures 6 and 7.

(3) The Office of International Affairs, Headquarters NASA will coordinate with the Department of Agriculture and State to lay the necessary ground work for a cooperative international program between Mexico and the U.S. as described previously. They will attempt to expand current arrangements of the joint Mexican-American Commission for the Control of Foot and Mouth Disease and the Screwworm Fly (Figure 7) to include provisions for remote sensing as an adjunct effort. Due to the technical expertise in the U.S. Earth Observations Program it is expedient to assume that U.S. aircraft, spacecraft, and data processing facilities will be utilized in the test program. In this case it is highly desirable that appropriately trained Mexican nationals be invited to participate in total technical management of the remote sensing program. This might include entomology experts from the research staff of the Secretaria de Agricultura as well as remote sensing staff from the Exterior Space Commission. The Mexican Defense Ministry would necessarily become involved in the case of aircraft overflight. Working space for a small contingent can be arranged at the Manned Spacecraft Center.

(4) Upon completion of general agreements between the two countries there will be formed a Mexican-American Coordination Group (Figure 6) to promote harmony in the day to day operations of the program, to favorable publicize the results of goals achieved in the joint effort, and to contribute toward further programs between the two nations as appropriate.

(5) The day to day operational management of the remote sensing portion of the test site program is conceived primarily as a function of the Health Applications Office, (Health Services Division, Life Sciences Directorate, Manned Spacecraft Center, NASA) located in Houston, Texas.

This office is colocated within the Earth Observations Division, (Science and Applications Directorate) at the same center. From this position, health related functional programs are conducted and supported by the entire staff including aircraft and data processing facilities. Appropriate staff members of the U.S. and Mexican governments should be invited to participate in routine management of field operations and analysis as members of the Remote Sensing Operations Team. In this way the necessary interface can be maintained between cognizant agencies. If resident, on site participation cannot be arranged, regular meetings must be held to coordinate the various aspects of the program.

(6) NASA proposes to furnish jointly with the Mexican space agency through contractor support arrangement, some technical and scientific staff to complement the research effort within the test site (Figure 6). Specifically it proposes to provide the expertise required to accumulate "ground truth" information necessary to understand data gathered by aircraft or spacecraft. Operation of the test site would be the responsibility of the joint Mexican-American Campaign for Control of the Screwworm Fly which is now in existence as a sub effort of the Mexican American Commission for the Control of Foot and Mouth Disease. Further details on organization, personnel, and support will be resolved in meetings of the interagency task force and by agreement with the joint Commission.

d. Costs

(1) It is proposed that the costs of the feasibility tests be the joint responsibility of the affected agencies of both governments. Operation of the ground test site could be adjucated the same way as that currently being conducted by the joint Campaign for the Control of the Screwworm Fly. NASA (MSC) has already budgeted for some technical assistance to ground truth support for the test site.

(2) It is proposed that if U.S. aircraft and/or spacecraft are used, costs supporting the feasibility test operations be borne by NASA as well as data reduction and processing costs.

(3) The Mexican government should be asked to provide staff support and travel funds for those members assigned to work at the Houston project office. NASA can supply necessary work space and office supplies to support routine work requirements.

(4) Unanticipated costs are expected to be shared on a 50 - 50 basis or approved by participating agencies of the governments concerned.

(5) USDA is encouraged to detail sufficient technical staff to NASA (MSC) Houston to support routine operations of the Remote Sensing Operations Team and the test site within Mexico. Office space and routine support can be arranged within the Health Applications Office.

THE CURRENT U.S./MEXICAN BORDER BARRIER

FIGURE 1

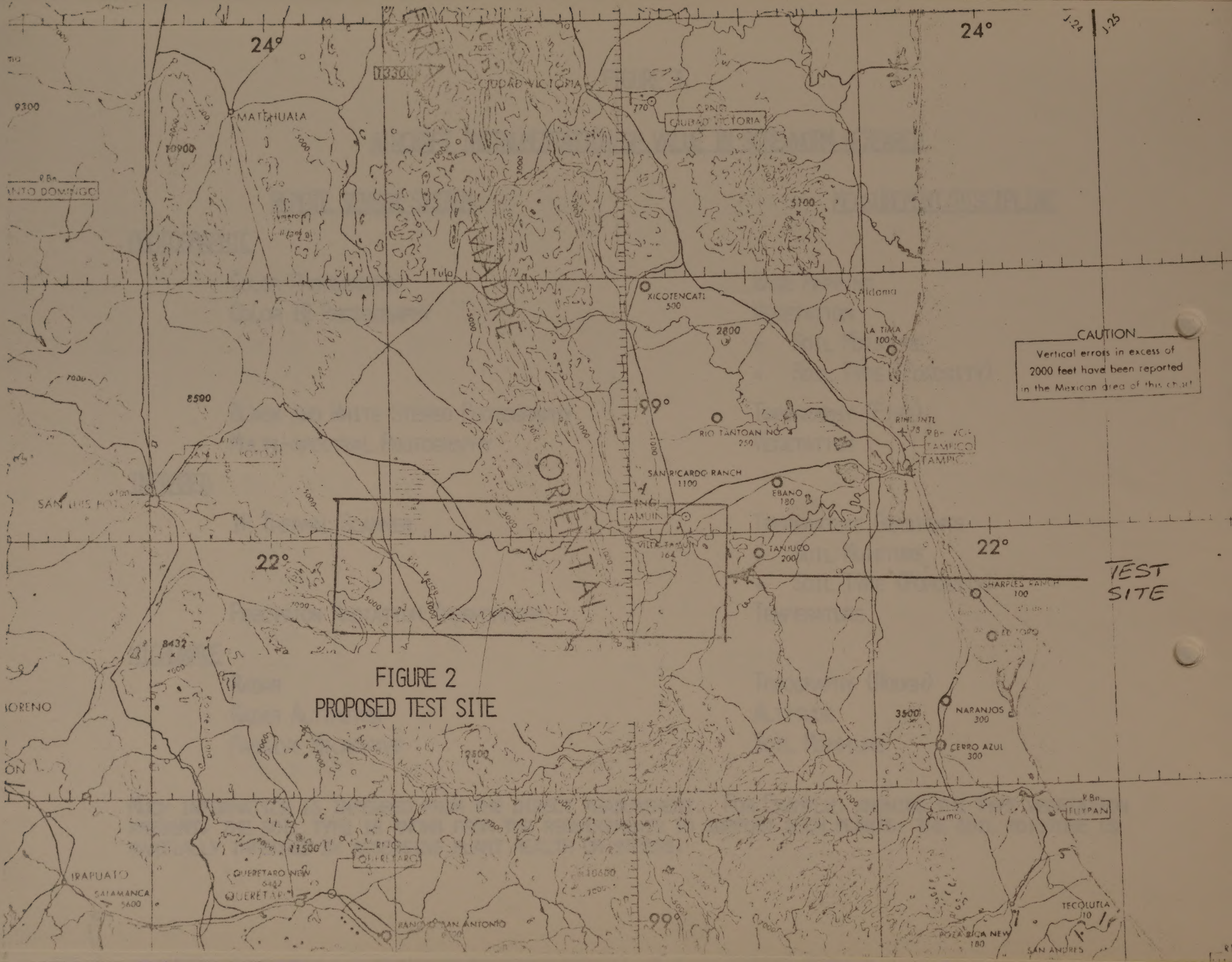


FIGURE 2
PROPOSED TEST SITE

FIGURE 3.

AIRCRAFT INSTRUMENTATION OF VALUE IN SCREWWORM RESEARCH

REMOTE SENSOR SYSTEM	MEASUREMENT/DISCIPLINE
PHOTOGRAPHIC	
COLOR PHOTOGRAPHY	BASE MAPPING
COLOR IR PHOTOGRAPHY	VEGETATION ∘ SOIL MOISTURE ∘ SOIL TYPE (POROSITY)
BLACK AND WHITE STEREO PHOTOGRAPHY	TOPOGRAPHY (FINE)
MULTI-SPECTRAL PHOTOGRAPHY	VEGETATION
INFRARED	
IR THERMAL SCANNER	TEMPERATURE GRADIENTS ∘ SOIL MOISTURE ∘ SOIL TYPE (POROSITY)
PRECISION RADIATION THERMOMETER	TEMPERATURE
MICROWAVE	
RADAR	TOPOGRAPHY (ROUGH)
RADAR ALTIMETER	ALTITUDE
PASSIVE MICROWAVE	SOIL MOISTURE

MUCH INFORMATION IS INFERRED FROM THE DIRECT MEASUREMENT. FOR EXAMPLE, KNOWING THE TYPE VEGETATION PRESENT, THE SOIL TYPE IS KNOWN FROM THE REQUIREMENTS TO SUPPORT SUCH PLANTS, THE SOIL MOISTURE IS PARTIALLY INFERRED BY ASSESSING PLANT HEALTH OR STRESS.

FIGURE 4.

ERTS INSTRUMENTATION OF VALUE IN SCREWWORM ENVIRONMENT RESEARCH

RETURN BEAM VIDICON (RBV)

No. 1	.475	.575
No. 2	.580	.680
No. 3	.690	.830

MULTISPECTRAL SCANNER (MSS)

CHANNEL 1	.5	.6	
CHANNEL 2	.6	.7	
CHANNEL 3	.7	.8	
CHANNEL 4	.8	1.1	
CHANNEL 5	10.4	12.6	(ERTS B ONLY)

(INSTANTANEOUS FIELD OF VIEW 260 FT. X 260 FT.)

FIGURE 5.

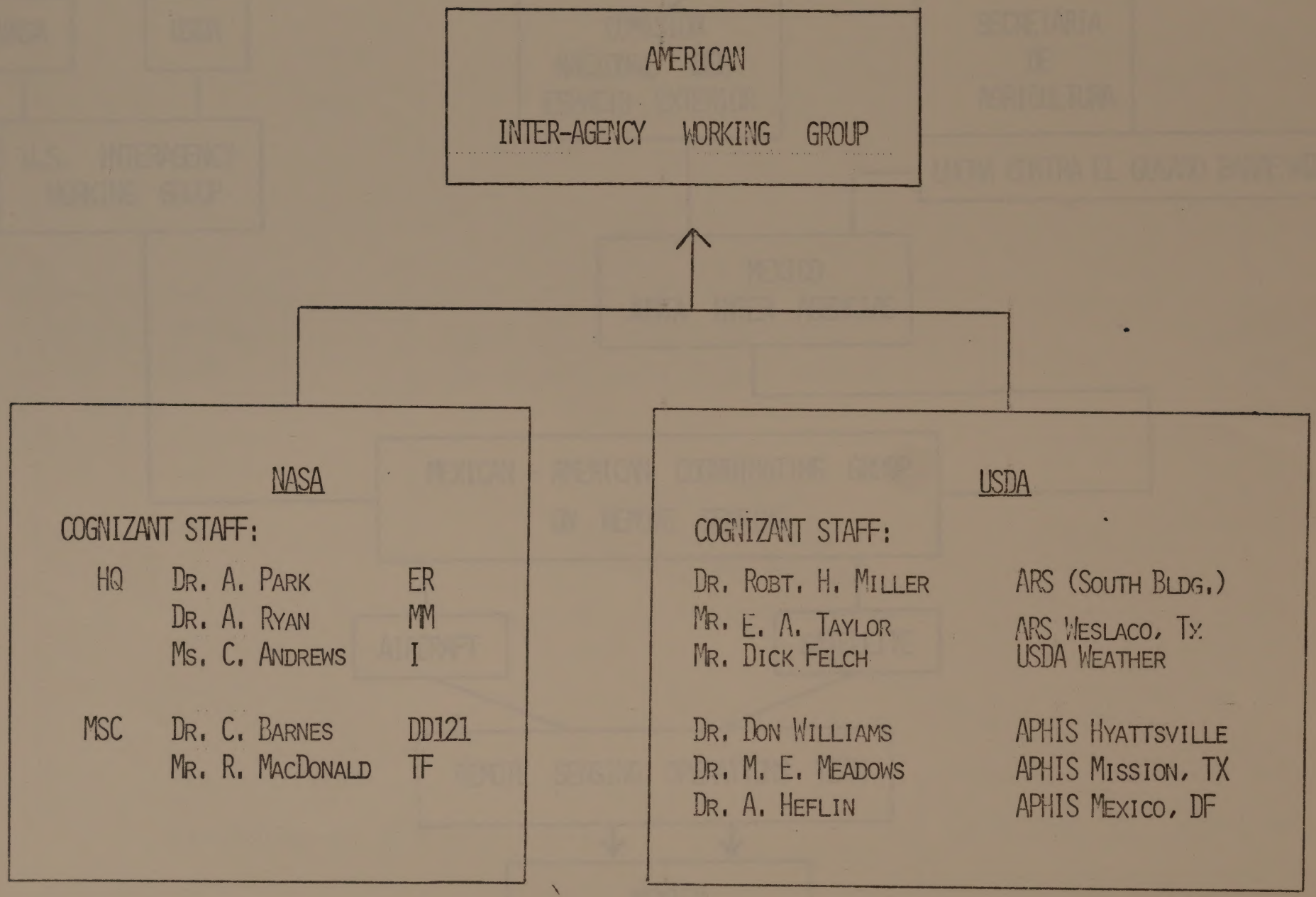

AMERICAN
INTER-AGENCY WORKING GROUP
NASA
COGNIZANT STAFF:
HQ DR. A. PARK ER
DR. A. RYAN MM
MS. C. ANDREWS I
MSC DR. C. BARNES DD121
MR. R. MACDONALD TF
USDA
COGNIZANT STAFF:
DR. ROBT. H. MILLER ARS (SOUTH BLDG.)
MR. E. A. TAYLOR ARS WESLACO, TX
MR. DICK FELCH USDA WEATHER
DR. DON WILLIAMS APHIS HYATTSVILLE
DR. M. E. MEADOWS APHIS MISSION, TX
DR. A. HEFLIN APHIS MEXICO, DF

FIGURE 6.

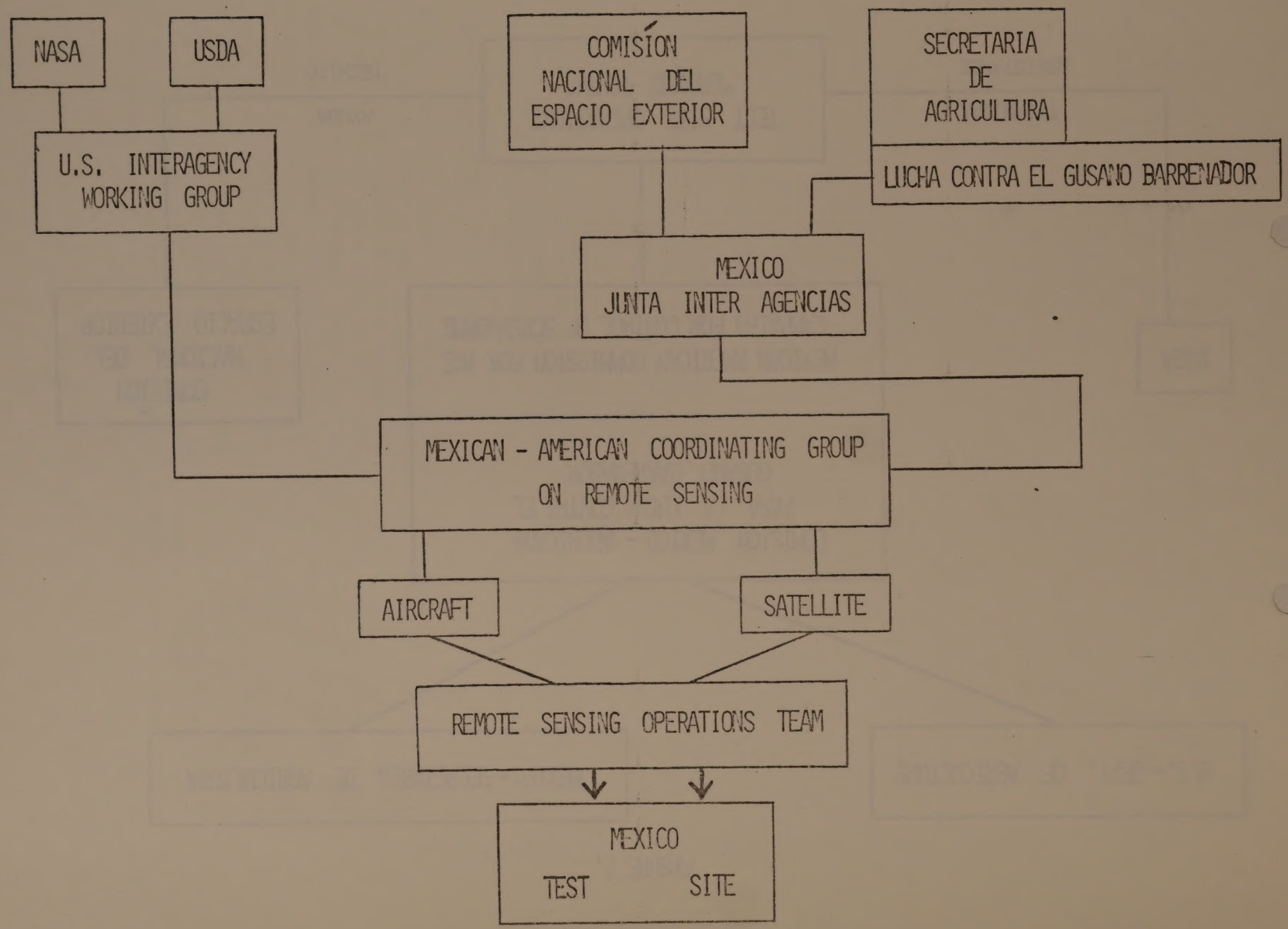
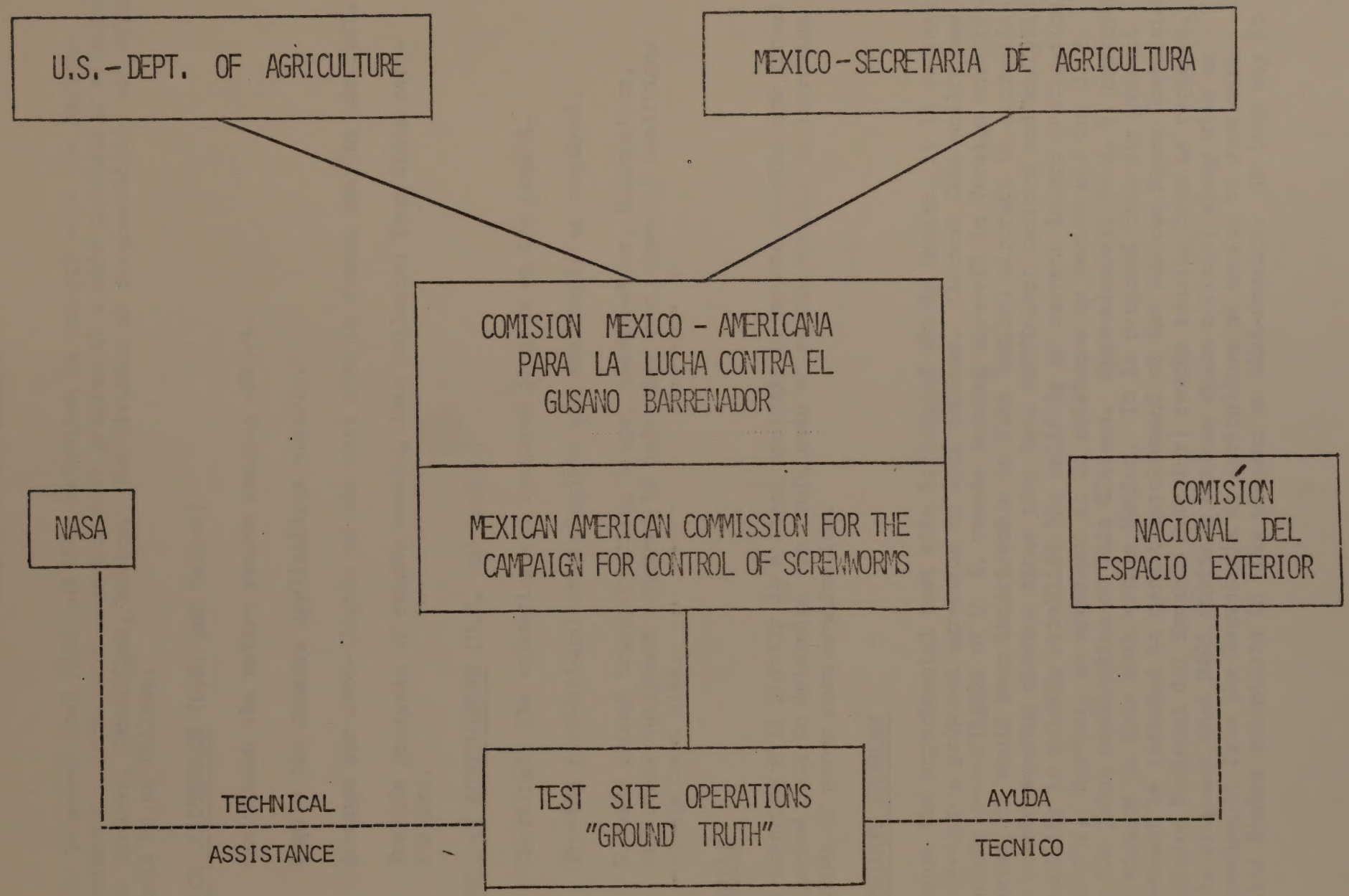

NASA
USDA
U.S. INTERAGENCY WORKING GROUP
COMISIÓN NACIONAL DEL ESPACIO EXTERIOR
SECRETARIA DE AGRICULTURA
LUCHA CONTRA EL GUSANO BARRENADOR
MEXICO JUNTA INTER AGENCIAS
MEXICAN - AMERICAN COORDINATING GROUP ON REMOTE SENSING
AIRCRAFT
SATELLITE
REMOTE SENSING OPERATIONS TEAM
MEXICO TEST SITE

FIGURE 7.


U.S.-DEPT. OF AGRICULTURE
MEXICO-SECRETARIA DE AGRICULTURA
COMISION MEXICO - AMERICANA PARA LA LUCHA CONTRA EL GUSANO BARRENADOR
MEXICAN AMERICAN COMMISSION FOR THE CAMPAIGN FOR CONTROL OF SCREWWORMS
NASA
COMISIÓN NACIONAL DEL ESPACIO EXTERIOR
TECHNICAL ASSISTANCE
TEST SITE OPERATIONS "GROUND TRUTH"
AYUDA TECNICO

A BRIEF PROPOSAL FOR A JOINT SCREW WORM RESEARCH EFFORT
NASA - USDA - MEXICO

It is proposed that NASA and USDA establish in concert with the Mexican government a screw worm research test program at a site previously selected near Linares, Tamaulipas, Mexico. The division of responsibility and effort should be as follows:

SPACE COMMISSION (U.S. and Mexico)

1. Coordinate the entire remote sensing effort.

2. Supply the sensors applications experts.

3. Arrange for over-flights of the test site by remote sensing aircraft.

4. Provide analysis of remote sensing data collected from these over-flights.

DEPTS. OF AGRICULTURE (U.S. and Mexico)

1. Coordinate the entomological research program on the ground.

2. Provide professional entomologists and assistants as required.

3. Provide ground transportation, traps, thermometers, hygrometers, and other equipment required to determine environmental conditions at the test site.

JOINTLY

The agencies will jointly do a final analysis of remote sensing and ground collected data to determine the usefulness of remote sensing in improving methods of screw worm eradication.

IMMEDIATE PROBLEM

Because the experimental test site is located within Mexico, it is necessary to develop a protocol agreeable to both nations. Current NASA policy may preclude over-flights of U. S. remote sensing aircraft in foreign countries. However, it would seem inadviseable to fund Mexican aircraft to accomplish the remote sensing mission since they lack sufficient sensors and analytical capability to quickly establish the validity of current insect eradication concepts. However, an agreement is in existence by Mexico and the U. S. for the joint eradication of this disease. Approximately 30 U. S. employees are engaged in this work within Mexico. It is proposed that the present agreement be extended to permit involvement of the Mexican Space Commission's (Comision Nacional del Espacio Exterior) remote sensing team as required. It is proposed that NASA invite a Mexican space official along with an entomologist from the Secretaria de Agricultura of Mexico to work with United States scientists in this program at NASA-Houston. In this way it

might be possible to develop an international team which would utilize a U. S. remote sensing aircraft for this project.

The approximate flying time from the U.S.D.A. experiment station, Weslaco, Texas, to the Mexican test site is 30 minutes and it is expected that no more than 3 or 4 over-flights per year would be required during the test program. Assuming success in the test schedule it might be feasible to utilize ERTS A satellite data for the actual eradication program which involves all of Mexico rather than the test site.

PRELIMINARY MEETING

Representatives of U. S. agencies affected by this proposal are invited to meet at the NASA Manned Spacecraft Center at 0900 on Monday, January 17, to discuss how this plan may be implemented. Meeting will be held in Room 860 , Building 2.

CMBarnes

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Houston, Texas 77058
Tel. (713) 483-4251

DD12/L31-72

JUL 27 1972

Mr. Charles W. Mathews
Associate Administrator for Applications
National Aeronautics and Space Administration
Washington, D. C. 20546

Dear Chuck:

Attached is a proposal for a feasibility test of the use of remote sensing in screwworm eradication. This test would be conducted in Mexico as a joint effort between NASA and the Department of Agriculture on the United States side and in consort with the Secretaria de Agricultura and the Comision Nacional del Espacio Exterior of the Mexican Government. If successful, the test could lead to definitive arrangements to assist the joint Mexican-American campaign for the control of the screwworm fly in its program to eradicate this pest from all of Mexico.

We have discussed the feasibility of this test with officials of the Animal and Plant Health Services, U. S. Department of Agriculture and believe that NASA can contribute to the presently planned program. If you concur with the proposal it is requested that the Office of International Affairs be asked to initiate the preliminary interagency and international arrangements for conducting the test.

Sincerely,
Original Signed By
CHRISTOPHER C. KRAFT, JR.

Christopher C. Kraft, Jr.
Director

Enclosure

cc:
NASA Hqs., Dr. Charles A. Berry, MM

DD12/CMBarnes:rs:5/11/72:5406

B. 5/11/72

AB- 7-25-72

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CONCURRENCES

OFFICE CODE ▶	TF/ RBMacDonald		TA/ AJCalio	DPS/ GCArmstrong	PA/ RSJohnston	HA/ CECharlesworth	AC/ GWSAbbey
INITIALS ▶							
DATE ▶				5-12-72		5-15-72	

NASA FORM 1267 OCT. 68 PREVIOUS EDITIONS MAY BE USED.

REPORT ON SCREWWORM MEETING
(Bushland, Knipling, and Lindquist)

I. Introduction

The meeting was held the afternoon of September 6 and the morning of September 7, 1979, at Mission, Texas, with AR and APHIS personnel. The objective was to thoroughly review the available information on the various screwworm strains and recommend changes in screwworm strains at the Mission and Tuxtla Gutierrez mass production facilities, if this seemed advantageous or necessary.

II. Current Situation and Strain

The Aricruz strain has been in factory production for 8-9 months. This strain has done an excellent job during 1979 as measured by case reports in both the United States and Mexico. Furthermore, the Aricruz strain, when coupled with intensive surveillance and treatment of cattle in the Aldama area, has resulted in a dramatic reduction in cases and a concurrent increase in sterility in the wild screwworm population in the same area.

In Sonora the number of cases in 1979 have been much less than in 1978. It is difficult to credit all of the improved situation in Sonora with the Aricruz strain; however, the general feeling among the people at the meeting was that Aricruz did contribute a major part of the improvement. Other factors which would improve the situation in Sonora include a reduction in the swath width from 4 to 2 miles, improved shipping methodology of the pupae, improved overall handling of the pupae and flies, and fewer cattle being shipped from south Mexico into Sonora. Two factors would tend to worsen the screwworm situation in Sonora during 1979 as compared with 1978. They were the good screwworm weather in 1979, and the increased number of cattle in Sonora in 1979 when compared to 1978. More inspectors were operating in Sonora in 1979 than in 1978, which would result in reports on a higher proportion of the cases that did occur, which represents further evidence of more effective screwworm suppression in 1979 than in 1978.

There is no indication that the Aricruz strain is decaying. However, in view of the rapid decline in effectiveness of the 009 strain after it had been in production for about one year, the possibility of a similar rapid decline in the Aricruz strain was a major factor in the recommendations that were made.

The use of SWASS in the United States greatly helped the screwworm situation in 1979 and offers prospects for improving the program in Mexico, if use is authorized.

The APHIS managers have agreed to seriously consider rearing different strains at Mission and Tuxtla Gutierrez. If two strains are reared, Mission reared flies would be released primarily in eastern Mexico and in Texas while Tuxtla Gutierrez reared flies would be released primarily in western Mexico.

III. Strain for Mission, Texas

A new strain (DE-9) has been developed and is ready for placing into factory production. This strain was developed from 13 egg masses collected from wounded sheep in the Aldama area. Based on the following tests the DE-9 strain appears to be a satisfactory strain for program use: mating with flies from other areas, egg hatch, egg production, pupae production per vat, larval size, longevity, and field release recoveries. With regard to the latter, the lack of a sufficient number and type of field tests is regrettable. Every effort should be made to improve the field evaluation of a strain including egg mass sterility data before it is put into factory production in the future. A new agility test has been developed which indicates that the DE-9 strain is satisfactory. Thus available information indicates that the DE-9 strain will be satisfactory for factory production.

It was recommended by the group that the DE-9 strain replace the Aricruz strain in the Mission mass production facility in October 1979. Efforts should be made to evaluate DE-9 in western Mexico by releases followed by collection of egg mass sterility data.

IV. Strain for Tuxtla Gutierrez, Mexico

At the present time no strain originating from Sonora (western Mexico) is available to put into the Tuxtla Gutierrez facility. There is a strain under development which originated from 4 egg masses, all of the long X type. This strain could be available by November or December if no serious problems develop. In addition, there are 9-10 strains from individual egg masses in the methods development facilities at Tuxtla; none of these are the long X type.

For operational reasons, the APHIS managers of the screwworm program wish to avoid a change in strains except in October. It is not possible to put a Sonoran strain of any type into the Tuxtla facility during 1979.

The merits of a narrow genetic based strain such as the long X type versus a broader genetic based strain were discussed at some length. There was almost unanimous agreement by individuals present that a very narrow based genetic strain should not be used without prior supporting field and laboratory data indicating that such strain would be as good as the mixed chromosome strains used in the past. Complete reliance on a narrow genetic strain poses considerable risk that such strain would not perform well against possible diversified native strains. This

would not rule out future use of one or more narrow genetic strains in specific areas in Mexico, if adequate data are obtained on the performance of such strains.

Thus, the options available for a strain in the Tuxtla Gutierrez factory were as follows: A) leave the Aricruz strain in the Tuxtla facility, B) use the DE-9 strain in Tuxtla as well as Mission.

It was agreed to recommend that the Aricruz strain would remain in Tuxtla Gutierrez until either it showed signs of decay or until October 1980 at which time it will be replaced by a strain developed from western Mexico flies. In the interim, the DE-9 strain will be evaluated in Sonora as rapidly as possible so that if the Aricruz strain does decay it can be replaced with the DE-9, providing that it is effective in Sonora. A new Sonoran strain will be developed utilizing the "old system." The performance of the Aricruz strain will be followed as closely as possible utilizing both laboratory and field evaluation in order to determine as accurately as possible if and when it does start to decay. If the DE-9 strain does not prove effective in Sonora, and the Aricruz strain starts to decay, then the best Sonoran strain available will be put into the Tuxtla Gutierrez facility, for release in western Mexico.

The Cooperative Agreement between the University of Texas and SEA/AR involves an evaluation in the Arriaga area of south Mexico to determine whether the development of a strain from a single chromosome type does in fact result in better flies than a strain developed by random collection of egg masses for use in developing a new strain.

V. Recommendations

The following recommendations are made for the consideration of the managers of the APHIS eradication program:

1. There is a serious need for improved methods of estimating sterility in wild populations where sterile flies are released. The use of wounded sheep (sheep pen method) is expensive and cumbersome. An alternative or supplementary method would be to collect egg masses from normally wounded cattle. This requires close collaboration between research and methods development personnel and the inspectors. There is an urgent need for more research to develop a wound attractant or some other effective attractant for mated female screwworm flies in order to obtain sterility data.

2. There needs to be a number of candidate strains available at all times. It is suggested that 2-3 strains be in the laboratory at all times in a condition to move directly into the mass rearing facilities. These candidate strains should be periodically replaced with new strains. Thus we recommend that one full-time professional be assigned the responsibility of strain development. Appropriate facilities and technicians must be made available for this program. This program should be the responsibility of Methods Development.

3. A standardized quality control procedure is badly needed. It was agreed that Dr. J. Wendell Snow would work with Methods Development and others in proposing such standardized quality control procedures. Included must be field tests to evaluate new strains before they are placed into factory production.

4. There needs to be an intensive effort to measure any decay in the Aricruz strain because it will remain in the Tuxtla Gutierrez facility for 1 more year. If evidence of severe deterioration is obtained, a strain change should be made as rapidly as possible.

5. There is a need for a method of identifying the source of an infestation. For example, if an infestation occurs in Beeville, Texas, it is important to know whether this infestation originated from Sonora, Aldama, or some other place in Mexico. At the present time, there are no techniques available for this type of source identification. We recommend that this technology be investigated.

6. There is a continuing need for more nutrition research in mass rearing of the screwworm. Of considerable importance is to increase the size of the larvae and to determine whether there is a cumulative loss of essential nutrients carried over from one generation to another. The latter could be evaluated by rearing one or more generations of the factory fly on a live animal (rabbit or sheep) and comparing the progeny with the factory strain.

7. It is recommended that the DE-9 strain be evaluated in Ocampo in a manner very similar to the way the Aricruz was evaluated in Aldama. The presence of an apparently high wild fly population in Ocampo will continue to threaten Aldama with reinfestation and thus there is a need to not only test the DE-9 strain in Ocampo but to eliminate the fly in Ocampo in order to protect Aldama and other areas in northeastern Mexico and south Texas.

8. We recommend that the proposed Arriaga tests to evaluate the single chromosome type of strain development be initiated as soon as possible. Furthermore, it is recommended that this field experiment be designed jointly by AR, UT, and APHIS Methods Development personnel.

9. Recommendation V of our February 28, 1979, report, dealing with the need for facilities to rear separate strains, is reinforced.

2. A stringent quality control program is early needed. It was agreed that Dr. U. Hendell Snow would work with Mr. Lewis Swingle and others in preparing such stringent quality control procedures. Technical assistance in field tests to establish the criteria before they are placed into factory production.

4. There needs to be an intensive effort to measure our lamp in the Arizona arctic because it will remain in the Vanguard Laboratory Holiday for 1 more year. If evidence of source deterioration is obtained, a serious change should be made as rapidly as possible.

5. There is a need for a method of identifying the source of an information. For example, if an informator points in Seattle, Tacoma, it is important to know whether this information originates from Seattle, Alaska, or some other place in Seattle. At the moment time, there are no continuous available for this type of source identification. We recommend that this technology be investigated.

6. There is a continuing need for more quantitative research in some phasing of the endeavors. Of considerable importance is an increase in the number of the Lamps and to determine whether there is a cumulative loss of essential materials during over long use measurements as another. The latter could be measured by running one of some laboratory or the laboratory fly on a time animal (weight or sound and measuring the power with the factory weight.

7. It is recommended that the CW-9 aircraft be evaluated in Canada in a manner very similar to the way the Mitter was evaluated in Alaska. The program of an aggressive high wind fly regulation in Canada will continue to operate Alaska with relocation and also there is a need to not only test the CW-9 aircraft in Canada but to relocate the fly in Canada in order to process Alaska and other areas in northwestern Canada and south Texas.

8. It recommended that the proposed Arctic tests be evaluate the single engine type of aircraft therefore be initiated as soon as possible. Furthermore, it is recommended that this field experiment be carried jointly by us, it, and other Canadian Development personnel.

9. Recommendation 5 of our Tentative 13, 1959, report, dealing with the need for facilities to test separate aircraft, is reiterated.

U.S. DEPARTMENT OF AGRICULTURE

REFERENCE SLIP

DATE 8-1-72

TO

Mr. Hart

- [ ] ACTION
- [ ] APPROVAL
- [ ] AS REQUESTED
- [ ] FOR COMMENT
- [x] FOR INFORMATION
- [ ] INITIALS
- [ ] NOTE AND FILE
- [ ] NOTE AND RETURN
- [ ] PER PHONE CALL
- [ ] RECOMMENDATION
- [ ] REPLY FOR SIGNATURE OF
- [ ] RETURNED
- [ ] SEE ME
- [ ] YOUR SIGNATURE

REMARKS Dr. Hacker of the Univ. of Houston, has been in touch with me and will contact you in late August concerning a formal proposal.

FROM

E. A. Taylor

GPO : 1964 OF—742-059

Contract NAS 9-12200
Job Order No. 79-905

TECHNICAL MEMORANDUM

THE NIMBUS IV SATELLITE IN SCREWWORM ERADICATION

BY

L. E. Giddings

Approved: R. E. Tokerud
R. E. Tokerud
Manager
Earth Observations Department

Distribution:

MSC: C. M. Barnes (7)
L. F. Childs
C. E. Fuller
H. J. Schneider
LEC: A. B. Thiermann

September 15, 1972

LOCKHEED ELECTRONICS COMPANY, HOUSTON AEROSPACE SYSTEMS DIVISION

THE NIMBUS IV SATELLITE IN SCREWWORM ERADICATION

Summary: This interim report introduces the potential of weather satellites in the campaign against screwworms north of Tehuantepec in Mexico. Overall strategy of the eradication program will be based on weather patterns in the eradication area. However, minor variations, such as rain showers in the dry season, can be very important and must be monitored. The thermal infrared channel of the THIR will be most useful to this project. Nimbus IV is considered representative of weather satellites that will be available and useful in the near future.

THE NIMBUS IV SATELLITE IN SCREWWORM ERADICATION

INTRODUCTION

Screwworms are still a serious threat to livestock in Texas and adjoining states. They overwinter in various areas of Mexico and reinfect Texas every summer, despite the sterile male-treated boundary between the two countries.

According to an agreement recently signed, United States and Mexico will cooperate in an effort to eliminate this pest North of the Isthmus of Tehuantepec. The bulk of the campaign is projected for 1974 or 1975, after the construction of a second sterile screwworm plant. However, smaller campaigns may begin earlier to familiarize workers with conditions in Mexico.

This interim report introduces the potential of weather satellites in the screwworm eradication project.

NIMBUS SATELLITES

The Nimbus type satellites represent an intermediate coverage of the earth. They scan the whole earth twice a day, once by day and once by night. Their resolution is intermediate at from one to ten kilometers. Their data is accessible daily in some form. They should provide the bulk of the real-time satellite aid to screwworm eradication.

At this writing there are no other operational weather satellites that can be used, but ITOSD and Nimbus V will be launched this year and Nimbus VI will be launched in 1974[1].

Nimbus IV has the sensors listed in Table 1[2]. It is unlikely that similar satellites will advance much more in the next two years, since the Nimbus series provides the proving grounds for sensors later incorporated into weather satellites.*

A brief evaluation of each Nimbus IV sensor is included in Table 1, together with its possible use in screwworm eradication. Note that only the THIR 10.5 - 12.5 μm channel will be of direct daily use.

USING THE THIR THERMAL CHANNEL

The thermal infrared channel of Nimbus IV is apparently the prototype of future instruments for viewing clouds. The Automatic Picture Transmission (APT) from previous satellites and the Image Dissector Camera System (IDCS) of Nimbus IV operate in visible light. They have no advantages over infrared radiometer scanners, and they will be replaced by the latter in future flights.

This channel measures infrared radiation due to the temperature of the surface of the earth or the surface of clouds that hide the earth. (Very thin clouds give a complex, intermediate case). Read-out takes the form of temperatures in degrees Kelvin, but these data must be interpreted with care. They represent "equivalent blackbody radiation temperatures;" that is, they represent the temperature the earth would have if it were perfectly black. The actual figures depend on temperature and emissivity of the surface and emissivity, in turn, depends on many interesting properties of the surface.

*See information on Nimbus E sensors in reference 1.

EXPERIMENT	SPECTRAL BANDS MICRONS	MAIN PURPOSE	USEFULNESS IN SCREWWORM ERADICATION
*Temperature Humidity Infrared Radiometer THIR, nearly identical to HRIR on Nimbus III	10.5-12.5	Daytime and Nighttime Surface and Cloud Top Temperatures and Cloud Mapping; 8 km resolution	Direct: Soil temperature, rains, cloud cover, general coordination of operations
	6.5-7.0	Atmospheric Water Vapor Mapping 22 km resolution	Indirect: Longer range forecasting by meteorologists
Infrared Interferometer Spectrometer (IRIS)	8-20	Atmospheric Temperature Profile, O_3, Water Vapor Surface Temperature and Minor Atmosphere Gases	Very indirect: of possible use to meteorologists
Satellite Infrared Spectrometer (SIRS)	11	Surface and Cloud Top Temperatures	Very indirect: of possible use to meteorologists
	13-15	Atmospheric Temperature Profile	Very indirect: of possible use to meteorologists
	19-36	Atmospheric Humidity Profile	Very indirect: of possible use to meteorologists
Monitor of Ultraviolet Solar Energy (MUSE)	0.12 0.16 0.18 0.21 0.26	Monitors Changes in Solar Radiation	None
Selective Chopper Radiometer (SCR)	13-15	Atmospheric Temperature Profile	Very indirect: of possible use to meteorologists
Filter Wedge Spectrometer (FWS)	1.2-2.4 3.2-6.4	Atmospheric Water Vapor	Very indirect: of possible use to meteorologists
Backscatter Ultraviolet Spectrometer (BUV)	0.25-0.34	Atmospheric upper air Ozone Distribution	None
*Image Dissector Camera System IDCS, like APT on other satellites	0.45-0.65	Daytime Cloud Mapping; will not be flown on future satellites	Direct: cloud cover perhaps soil moisture (but probably will not be available
Interrogation, Recording, Location System (IRLS)	-	Data Collection from Platforms, such as balloons	None

Table 1 Nimbus IV Meteorological Experiments

Since the pupa of the screwworm does not survive extreme cold, it is important to know soil temperature. Since ground temperatures vary with altitudes, the cold limit of survival of the papae will shift up and down with variations of insolation. Nimbus IV daily coverage will help us tell where the screwworms can survive and where they can't.

The screwworm also fails to survive drought. Fortunately, the weather in Mexico is predictable in a way unfamiliar to residents in most of the continental United States*. Since minimum incidence of screwworms coincides with the winter dry season, the eradication planning team must know of all rainfall in supposedly dry areas. Such rainfall should show up well on THIR day and night scans because of changes in soil temperature and emissivity.

Coordination of screwworm eradication depends on knowing how well a given year follows the normal climatological pattern. A Nimbus satellite can furnish just such information in real time on a daily basis. For example, it will show at a glance whether cloud cover, rains, and temperatures are normal.

REDUCTION OF DATA

Remote sensing will be of greatest use in the winter dry season in Mexico. At that time, native screwworm populations are smallest and most inactive, and hence most vulnerable to the sterile male method of control.

The seasonal pattern is quite regular, both in function of time and station elevation. This regularity should allow calibration of dry soil temperatures, preferably for a full year. Given such a calibration, and given the general predictability of seasonal changes of temperature, variations from normal seasonal patterns can be measured. Overall long-term project strategy must be based on the overall prediction of climate. It must also allow short-term adjustments to be made, based on exceptions to the normal climatic pattern.

Soil moisture is low in most of Mexico during winter. Because of this, screwworm pupae cannot survive in many areas without some rainfall. Rainfall will normally lower soil temperatures, and this should be most noticeable in thermal infrared emission at night. Therefore, showers that allow screwworms to survive in an area should be recognizable by sudden changes in temperature.

*See Appendix A

USES OF OTHER NIMBUS SENSORS

Apparently all APT-type pictures in visible light, such as ICDC, will be discontinued soon. However, if any remain during screwworm eradication in Mexico, they can be used for cloud cover and ground moisture, much like the THIR thermal infrared channel. They will not yield ground temperatures, however.

The THIR water vapor channel will probably not be directly useful, although it could assist meteorologists in long range predictions. This channel measures humidity in the upper troposphere and lower stratosphere, that is, from 5 to 18 km, with a ground resolution of about 20 km^3. Its data do not correlate well with ground-level humidity.

Sensors which measure atmospheric temperature and humidity profiles may aid meteorologists in their long range predictions. They do not appear to be useful on a day-to-day basis. Ozone monitors, solar monitors, and IRLS data collection systems do not appear useful to this project.

PRACTICALITY OF NIMBUS-TYPE DATA

Daily availability and synoptic coverage mark the two obvious advantages of Nimbus-type data. Raw THIR pictures can be taken from a satellite as it passes over, or refined pictures can be received from Goddard Space Flight Center the same day. In addition, images can be automatically processed by computer at Goddard and received as data maps; for example, we can get daily maps with printed temperatures for all areas in Mexico.

It might appear that resolution is not sufficient for such a detailed operation. However, some working plans involve as much as 150,000 square miles (388,000 square kilometers) per week*. Since ground resolution is 8 km, a data cell can be considered 64 square kilometers. Therefore, 60,000 data cells would be flown per week, or 1200 data cells would be flown per day. (ITOS D has a resolution of one kilometer.)

This calculation suggests that Nimbus type THIR data contain enough detail to be very useful. We will soon make detailed studies on actual Nimbus imagery for five consecutive days.

SUMMARY

This interim report presents information available through the facilities at MSC and by phone conversations with personnel at

*See calculations in Appendix B.

Goddard. At this stage, it appears that Nimbus-type imagery will be the most useful of all satellite data. In particular, the thermal channel of the scanning infrared radiometer offers daily real-time information vitally useful in screwworm eradication.

REFERENCES

1. David Pitts, Trip Report of 7 April 1972 on the Second Synposium on Meteorological Observations and Instrumentation.

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3. Raschke, E., and W. R. Bandeen, J. App. Meteorology, 6, 468 (1967)

4. Sanidad Animal de Mexico and Div. Animal Health of U. S. D.A., Report of Findings at the Mexico - United States Screwworm Survey and Plan of Operations for a Possible Eradication Program in Mexico, 15 Sept. 1966.

5. USNWS World-wide Airfield Summaries, Vol. VII, Central America (sic), pages xx-120, MSC:N68-32725, Washington, February 1968

APPENDIX A

THE WEATHER OF MEXICO

There is a predictability in Mexican weather that will aid us in the eradiction of screwworms. There are many useful descriptions of the weather, such as the report in the Screwworm Survey[4] and such meteorological data is dependable.

As an illustration, Figure 2 shows the rainfall for the geographic-climatological areas in Figures 3[5]. The obvious pattern is very favorable for screwworm eradication.

Largest and Smallest Mean Precipitation

in the Various Zones of Mexico

(Zones are delineated in Figure 3)

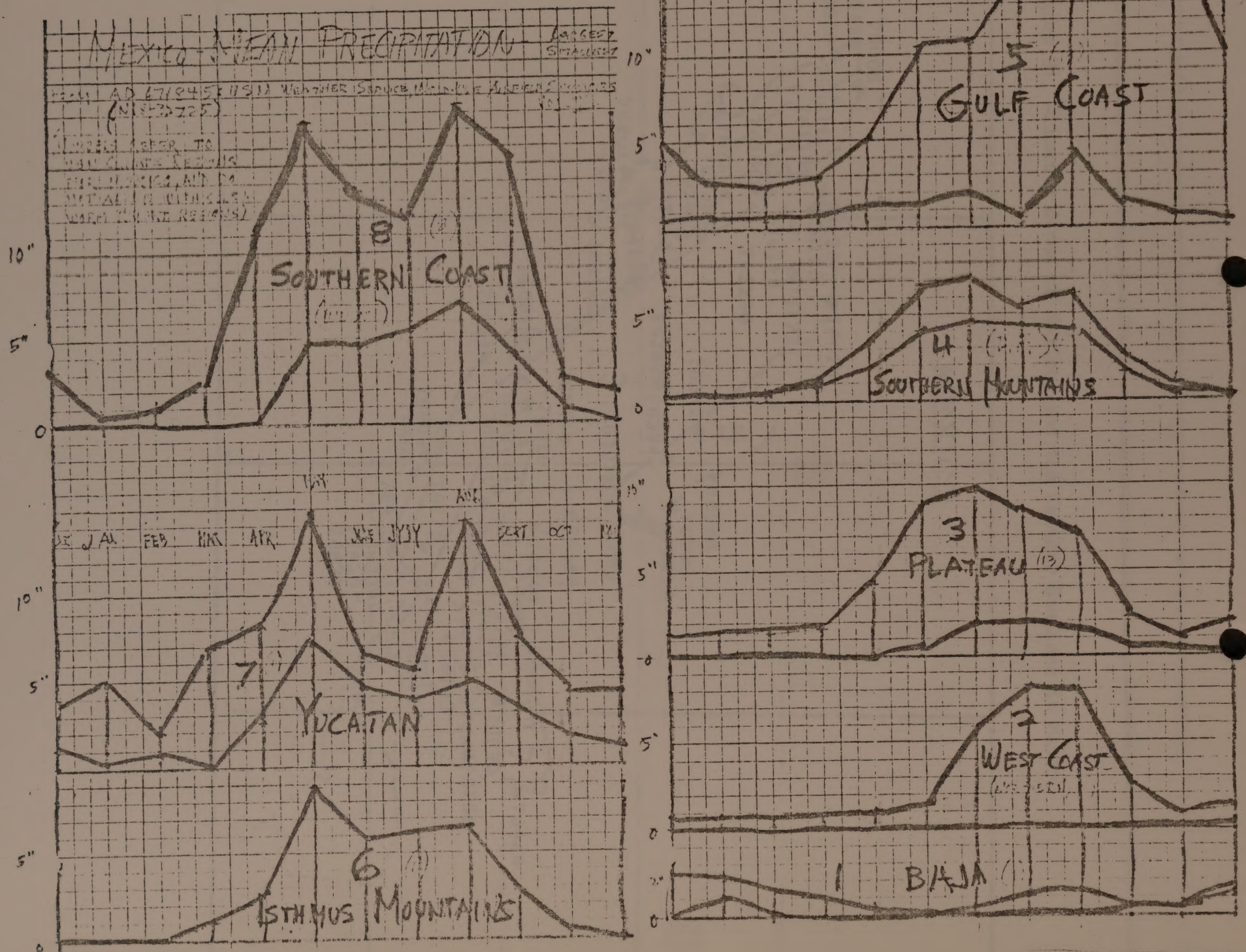

Figure 3: Climatic Zones of Mexico, and the Weather Stations in Mexico

APPENDIX B

TOTAL AREA TO BE OVERFLOWN EACH WEEK

We need to know the number of square miles or kilometers to be overflown in a day or week. This appendix shows my present understanding of the various possibilities.

During the present infestation Dr. M. E. Meadows (Veterinarian in charge, Screwworm Eradication Program) estimates that 25,000 miles are flown each week. Since flights are made in three mile swaths, this is a coverage of 75,000 square miles (180,000 square kilometers) per week. Since six mile swaths are flown each day, this is equivalent to a coverage of 30,000 square miles (72,000 square kilometers) per day. (If we assume a production rate of 180,000,000 flies per week, 2,400 flies are dropped for each square mile.)

A report of the Mexico-U. S. Screwworm Survey suggests that 2,000 flies be dropped per square mile, and that a total of 300,000,000 flies be dropped per week at the beginning of the concentrated eradication program. This implies overflights of 150,000 square miles (390,000 square kilometers) per week or 30,000 square miles (78,000 square kilometers per day).

Assuming that present operations continue, and that the survey suggestion is followed, overflights would total 225,000 square miles (570,000 square kilometers) per week or 45,000 square miles (114,000 square kilometers) per day.

For perspective, note that Mexico has a total area of 762,000 square miles (nearly 2,000,000 square kilometers). Apparently, a total area of 520,000 square miles (1,250,000 square kilometers) constitutes the proposed zone of operations[4]. If no areas are overflown twice, the entire eradication zone can be treated every two weeks.

File

Proposed

Specific Operations

of the

Remote Sensing Operations Team

at MSC and at the Test Site in Mexico

This report supplements "A Proposal for a Feasibility Test of the Use of Remote Sensing in Screwworm Eradication". It is designed to show one concept of specific tasks of the Remote Sensing Operations Team mentioned in that report. It also lists the organizations involved, directly or indirectly, in the operation of the team, and it outlines some of their responsibilities.

16 October 1972

This report presents one simplified, explicit concept of operations of the Remote Sensing Operations Team in the eradication of screwworms in Mexico. Although the concepts are fairly firm, details may well be modified as planning advances.

The study phase will consist of the fundamental studies that must precede participation in the eradication program. The action phase, necessarily based wholly on the results of the study phase, involves real time participation in eradication operations.

This report first presents a summary of the operations of the team. It then outlines specific tasks to be performed at the two sites in the study phase. Finally, it suggests a plan for the action phase.

SUMMARY

Project Motives

Test concepts; calibrate sensors; obtain background data; assist in eradication campaign.

Time Scale

Entire project will take five years. Most probable date for completion of the Salinas Cruz screwworm plant is summer, 1974, and therefore action phase could begin at that time. Assuming January 1973 as starting date, full study phase would occupy 1½ years, combined study and action phase would occupy a year, and pure action phase would occupy 2½ years. If completion of the plant is delayed, the pure study phase would be extended. Study phase must occupy 2½ years to encompass two dry seasons.

Organizations Involved

U.S.: National Aeronautics and Space Agency, Health Applications Office (NASA-HAO)
Contractor: Lockheed Electronics Company (NASA-LEC)
Contractor: University of Texas School of Public Health (NASA-UTSPH)
U.S. Department of Agriculture, Agricultural Research Service (ARS)
National Oceanic and Atmospheric Administration (NOAA)
(Perhaps NASA offices for NIMBUS, ERTS, and ATS)

Mexico: Comisión Nacional del Espacio Exterior (CNEE)
Secretaría de Agricultura (SA)

Personnel, Test Site in Mexico

U.S.: One doctoral level entomologist (NASA-UTSPH)
Two entomologists or technicians (ARS)

Mexico: Part time services of two field technicians (SA)

Personnel, HAO offices at MSC, Houston

U.S.: Co-Director of Project (NASA-HAO)
One Physical Scientist (NASA-LEC)
One Biological Scientist (NASA-LEC)

Mexico: Co-Director of Project (CNEE)
One Biological Scientist (SA)

Physical Resources at Mexican Test Site

U.S.: Furnish 3 pickups, about 4 pens, about 20 fly traps, about 35 micro weather stations, and other agricultural and entomological equipment (ARS). Furnish one stereoscopic microscope and one recording hygrothermograph (NASA-UTSPH)

Mexico: Furnish only test site

Resources at HAO, MSC, Houston

U.S.: Furnish work space, and all facilities (NASA-HAO)

Mexico: None

STUDY PHASE-OPERATIONS AT THE TEST SITE IN MEXICO

For at least two and a half years, U. S. and Mexican scientists will need to study the test site. They will collect and analyze the data needed that will be needed later for the full-scale screwworm eradication program. Specifically, they will collaborate in the following ecological projects.

1. Population Density - It will be necessary to determine density of screwworm flies as a function of time and the physical variables of the test site. This will require a study of the environments and vegetation zones of the test site, as well as the establishment of a representative grid of baited traps. They will need to make regular collections from the traps and classify the insects.

2. Infestation Dynamics - They must also analyze the amount of infestation to be expected from the local population density. This will require experiments with penned livestock in various parts of the test site, examining the animals for the numbers of egg masses in wounds.

3. Life Table - The entomologist will need to construct a life table for the complete cycle of the screwworm fly in its native habitats. This applied research project will require analysis of fly

density and infestation dynamics data and it will also require experiments with native and sterile flies.

4. Test Site Ecology - Local fauna and flora may help maintain a reservoir of screwworm infestations. Therefore, some studies must be made of their populations in the test site.

5. Weather Variables - The entomologist will need to correlate the above data with microclimates and vegetative cover of the test site. In addition, remotely sensed data, discussed below, must be calibrated by ground truth. Both require that weather variables be monitored regularly in the site. In practice, this will require that small weather stations be deployed throughout the area, and that measurements be taken from them daily.

6. Correlate Data - The entomologist will correlate these field data with previous knowledge of the screwworm. This will be a cooperative task with the scientists at MSC-HAO.

STUDY PHASE-OPERATION AT MSC, HOUSTON

U.S. and Mexican personnel will receive and process remotely sensed data in the Health Applications Office at MSC. They will study this data for possible application to the screwworm eradication project. The end product of their studies should be a mechanism for supplying user-oriented reports and maps to the directors of the eradication project.

During this study phase the personnel at MSC will need some latitude of experimentation. However, they will have little need for real time use of remotely sensed data; delays in reception of a week or so will not hurt most of their operations. Specifically, studies at MSC-HAO will begin as follows, and will evolve as necessary.

1) Obtain high resolution infrared scans of all Mexico. These will be available four times a day (two by day and two by night) for thermal infrared channels from ITOS-4 (SR) and NIMBUS-E (THIR). Ungridded data from both will be available at MSC by direct reception from the satellites at MSC. The superior gridded and transformed pictures can be obtained through NOAA offices.

2) Interpret the daily radiometer scans in terms of ground temperature, soil moisture, cloud cover, and precipitation as possible. Correlate these data with meteorological data and screwworm incidence data from the test site. False color image enhancement will probably be the primary instrumental technique.

3) Obtain very high resolution scans of the test site on an occasional basis, such as once a week. These are also available from ITOS-4 and NIMBUS E. They are continously broadcast but cannot be received at MSC for lack of appropriate receiving equipment. Arrangements will be

made with officials of NOAA for ITOS-4 data and with NASA for NIMBUS E data. This data will be used to aid in interpretation of the lower resolution scans.

4) Obtain visible scans of Mexico as available, to supplement interpretation of the lower resolution thermal IR scans. These are also available from ITOS-4 through NOAA.

5) Acquire ERTS-1 imagery of the test site. This will be used, with cooperation of test site personnel, to establish vegetation, topography and geography of the test area.

6) Prepare maps of the test site and surroundings, showing the variables likely to affect screwworm incidence. These maps would be used in the ecological study of the screwworm.

7) Indications from present limited knowledge of the ecology of the screwworm suggest that vegetation is a key factor; therefore, MSC-HAO personnel would lend assistance toward projects of construction of a detailed all-Mexico vegetation map.

8) Other sources of remotely-sensed information may need to be explored. For example, changing cloud patterns sensed by ATS-III, interpreted by a professional meteorologist, yield daily or even hourly information on rains. The possible application of this technique needs to be explored. In addition there may be need for the more detailed information available from overflights by airplane.

9) The same group must maintain itself aware of the new remotely sensed information that is becoming available. It is probably, for example, that high resolution infrared radiometer data will be available every 25 minutes from the geostationary GOES satellite in late 1973. This will materially increase the quality of scanning radiometer data available to the project.

10) Finally, the group must explore and, finally, define the mechanism of furnishing information to the directors of the eradication campaign.

ACTION PHASE - REAL TIME ASSISTANCE TO SCREWWORM ERADICATION

The practical application of remote sensing to screwworm eradication needs to be defined by the study phase as outlined above. The following are only working presumptions, based on our studies to date.

Material resources required for the action phase should be about the same as the definition phase. The number of technical people in the MSC office should remain the same. Test site personnel will probably be reduced by loss of the two USDA-ARS technicians; however, there will still be a need for extensive monitoring of screwworm populations, both in the test area and elsewhere in Mexico.

The MSC office will furnish user-oriented documents to the directors of the eradication project. The exact nature of these documents awaits definition. Such documents will probably include maps showing areas in which screwworms can emerge from pupae because of unusual weather conditions, such as atypical rainfall. Directors of the project must have most of these materials daily if they are to plan day-to-day operations with the help of remotely sensed data.

Ed

File 11/2/72

I talked with Charlie Barnes this p.m. and he wanted to know about test sites. I told him that you said it would be best for Rodriguez and Hugh Graham to get together. So he said he would have Rodriguez contact Graham next week. He also indicated that he would like to travel to Mexico with them when they go.

Of the Michigan remote sensing meeting he said they talked with the Space people from Mexico and they didn't know anything about the Sorghum proposal. They (Mex. Space Personnel) are very enthusiastic but they say their Agriculture people have apparently not followed through.

They (NASA) are apparently having some difficulty with their International Affairs Group and in discussing this with Circle Park, he said that the proposal would be best received by the Int. Affairs Group if the Mexican Agriculture people would propose something on Sorghum. Barnes said that this Villanueva that they have had contact with is pretty passive about the whole thing and he doesn't expect much help from him.

Barnes and Arch Park are planning a meeting with their International Affairs people sometime next week and he would like to have someone from our group attend at Houston. I told him that we were going to be in New Orleans next week and he said maybe he could arrange the meeting so that we could attend on the way back. I told him that I would mention this to you. He also said that he was planning on going to New Orleans earlier in the week (next week) if he could get to see Cof and perhaps Cooper. He ~~[illegible]~~ wanted HC's phone number so he could try to arrange for a ~~[illegible]~~ Wednesday visit.

I finish up by telling him that you would get the suggestions on his proposal back to him as soon as you were able to pull it together. He said he would like to have it so that he could update it for his next go around with his people.

Bill

NOV 13 1972

E. A. Taylor
Weslaco, Tex
for 324

November 7, 1972

Dr. C. M. Barnes
Manned Space Craft Center
National Aeronautics and
Space Administration
Houston, Texas

Dear Dr. Barnes:

This is in further reference to our discussion thismorning regarding Agricultural Research Service (ARS) interest in cooperating with National Aeronautics and Space Administration (NASA) in research on remote sensing to detect screwworm populations. As you know, ARS has responsibility for research in support of the screwworm eradication program being carried out by Animal and Plant Health Inspection Service. In view of the U.S.-Mexican agreement to carry the program into Mexico as far as Tehuantepec, ARS is undertaking additional studies in order to obtain data on the screwworm that will support the eradication program as itmoves into a more tropical environment.

We have read your "Proposal for a Feasibility Test of the Use of Remote Sensing in Screwworm Eradication" and the report "Specific Operations of the Remote Sensing Operations Team (Proposed)" and wish to affirm the desire of ARS toccooperate with NASA in research on remote sensing in relation to screwworm eradication. We will be pleased to work toward the establishment of a cooperative work project at a test site in Mexico to determine the relation between remotely sensed variables and in ground observations of screwworm environmental factors. We understand that such a site is planned to begin operations in January 1973 and continue until about June 1975 in order to allow thorough coverage of two complete annual cycles of screwworm infestations.

Work at the test site will be concentrated in the following tasks, which appear to be of mostiinterest at this time. Density of screwworm flies as a function of time and physical

variables will be measured by means of traps. The dynamics of infestation will be examined by means of wounded, penned animals and other animals at the site. Life tables will be constructed to relate the life cycle of the screwworm to physical variables. Studies of local ecology will be made as needed and may require experimentation with native and sterile flies. Weather variables will be measured for correlation with entomological and remotely sensed data. These data may well indicate that other tests are needed at the test site.

We suggest that our two agencies enter into a memorandum of understanding which would set forth the conditions for a truly cooperative program in Mexico. Included in the memorandum would be a provision for ARS to provide technical staff assistance for the entomological phases of the research as well as certain equipment and supplies that would be needed to support the studies. In addition, the memorandum would designate NASA's intent to provide a qualified research entomologist, as well as support costs, to be located on-site. If this suggestion meets with your approval, we will be glad to work with you and appropriate NASA officials in developing such a document.

H C Cox
Acting Associate
Deputy Administrator

ARS:DASR:HCCox:mlw 11/7/72

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
INTERNATIONAL PROGRAMS DIVISION
HYATTSVILLE, MARYLAND 20782

NOV 9 1972

November 8, 1972

Subject: Bilateral Agreement with Mexico

To: Edgar A. Taylor
Acting Area Director, Weslaco, Texas
Southern Region, ARS

This is in reference to your telephone call of this date. Colonel Barnes called shortly after our discussion with you. We agreed to have someone present at the meeting which will be held in Dr. Parks' office at NASA, Thursday, November 9, at 2 p.m.

There are enclosed several documents dealing with proposed cooperation between United States and Mexico in the areas of science and technology, technician exchange, remote sensing, etc. The technician exchange is being coordinated in the United States by the Department of State and science and technological cooperation by the National Science Foundation.

Mr. Starkey and I met representatives from the Mexican Council for Science and Technology several weeks ago. They are to furnish us with biodata on young scientists whom they desire to have working experience in the United States. That portion dealing with scientific and technological cooperation has has not been initiated, but one of the enclosures furnishes the information that was made available to the Department of State and the Mexican Government as to our interests.

We would appreciate being kept informed of any cooperative activities that you may propose.

Kenneth A. Haines

Kenneth A. Haines
Associate Director

5 Enclosures

cc:
A. W. Cooper

Harris from LPD

the future we may achieve a balance of development within a framework of freedom, which is so necessary for the human spirit and the spirit of democracy, to which we may ever aspire, and so we may work together in the future for the welfare of our peoples.

Thank you very much.

ANNOUNCEMENT OF AGREEMENTS

White House press release dated June 15

In a ceremony at the White House on the occasion of the state visit of President Luis Echeverría, Secretary of State William Rogers and the Mexican Secretary of Foreign Relations, Emilio O. Rabasa, exchanged diplomatic notes bringing into effect a series of bilateral agreements between the United States and Mexico in the scientific, technological, and cultural fields.

Agreement for Scientific and Technological Cooperation

The agreement provides for a broad program of cooperation in areas of science and technology, with a view to contributing to the greater mutual progress of the two countries. It envisions more specifically the strengthening of economic and social development, the intensification of relations between the two countries' scientists and technicians, and through combined efforts facilitation and increase of the exchange of persons, ideas, skills, experience, and information.

The two governments will establish a mixed commission for the formulation, orientation, and review of the programs promoted under the agreement, to meet alternately in the United States and Mexico. It will examine activities periodically and make recommendations, suggesting useful specific projects or subjects under the program.

Each government will appoint an executive agency to implement its part of the program, to work closely with its counterpart, and to report jointly and periodically to the mixed commission.

The program may include the exchange of scientists and technicians, the execution of joint research and personnel training projects, joint meetings, and other activity which will, as with the exchange especially of young technicians, advance the objectives of the program.

Except in the case of particular understandings concerning the financing of certain agreements, each government will bear the cost of executing its responsibilities under the program. The governments may invite participation when appropriate of international organizations. All scientific and technological information derived from the cooperative program will be made available to the world's scientific and technological community.

Technician Exchange

This agreement contemplates the exchange of young technicians and scientists between the United States and Mexico.

An outgrowth of President Echeverría's deep personal interest in developing Mexico's technology to match and give impetus to her economic growth and to provide increased employment for her young people, the exchange will be carried out under the terms of the broader agreement on science and technology referred to above.

Initially, the United States has offered to provide training for some 100 Mexican technicians and scientists, largely in government training facilities. The agencies ready to offer training include the Departments of Agriculture; Health, Education, and Welfare; Transportation; Interior; and the U.S. Atomic Energy Commission.

Mexico is prepared to offer a similar number of training positions to young technicians and scientists from the United States.

Details of the United States and Mexican contributions to the program will be worked out jointly between the two governments.

In implementing President Echeverría's philosophy, Mexico has established similar exchange programs with several countries, including France and Japan.

Cultural Agreement

This new agreement, which revises and streamlines the procedures of a 1949 agreement, calls for annual meetings by a Mexican-U.S. Commission on Cultural Cooperation. This joint commission will orient and review the cultural exchange programs between the two countries, and will provide information, advice, and recommendations to organizations which conduct activities in this field.

In his note, Secretary Rabasa referred to the "fruitful interchange between the two countries in the fields of education and culture" which had been fostered by the earlier agreement and expressed the hope this new agreement will usefully update the functions of the joint commission and give added impetus to cultural relations between Mexico and the United States.

Remote Sensing Agreement

This agreement represents the extension until July 1, 1974, of a 1968 agreement covering cooperative research in remote sensing for earth surveys. In

addition, it modifies the earlier agreement by providing that the National Aeronautics and Space Administration will use its best efforts to acquire and process Earth Resources Technology Satellite data obtained over Mexico. Further, NASA will provide training in remote sensing data techniques to a number of qualified Mexican technicians.

TEXT OF JOINT COMMUNIQUE

White House press release (Key Biscayne, Fla.) dated June 17

President Richard Nixon and President Luis Echeverria Alvarez welcomed this opportunity to renew their personal friendship and the cordial dialogue which began at their first meeting here in 1970. They regarded this visit as particularly appropriate at a time when the eyes of the world have been focused on President Nixon's recent visits to Peking and Moscow. The visit of the Mexican President to the United States serves to direct broad attention to the equally important tasks of advancing new approaches to Latin America and the less developed nations of the world.

They also agreed that their meetings had contributed to the establishment of a new era, an opening characterized by a spirit of frankness, with Mexico and which they hoped would characterize intra-Hemispheric relations.

The two Presidents exchanged impressions on world and Western Hemisphere affairs in considerable detail. President Nixon described his talks with the Chinese and Soviet leaders. President Echeverria recounted his experiences on recent visits to Japan, Chile and Peru. They found this review informative, useful as well as stimulating. They were firmly united in the view that world peace with social justice is essential to the well-being of all mankind.

The Presidents discussed overall relations between their two countries—political and economic affairs, and cooperation in the scientific, technical, cultural and other fields.

The President of the United States recognized the important role developing countries could and should play in erecting a new international monetary system and in progressing toward a free and fair trading system. In endorsing trade policies more responsive to the problems of both developed and developing countries, he reaffirmed his intention to seek congressional authorization at the appropriate time for the United States to participate with other industrialized countries in a system of Generalized Tariff Preferences for imports from developing countries.

Regarding the problem of the salinity of the Colorado River, President Echeverria told President Nixon that Mexico reiterates its position as regards receiving its assignment of original waters from the Colorado River, to which the Treaty of February 3, 1944 refers, and therefore, with the same quality as those derived from the Imperial Dam.

To this, President Nixon replied that this was a highly complex problem that needed careful examination of all aspects. He was impressed by the presentation made by President Echeverria and would study it closely. It was his sincere desire to find a definitive, equitable and just solution to this problem at the earliest possible time because of the importance both nations attach to this matter.

As a demonstration of this intent and of the goodwill of the United States in this connection, he was prepared to:

(a) undertake certain actions immediately to improve the quality of water going to Mexico;

(b) designate a special representative to begin work immediately to find a permanent, definitive and just solution of this problem;

(c) instruct the special representative to submit a report to him by the end of this year;

(d) submit this proposal, once it has the approval of this Government to President Echeverria for his consideration and approval.

President Echeverria said that he recognized the goodwill of President Nixon and his interest in finding a definitive solution to this problem at the earliest possible time. He added that based on two recent trips to the Mexicali Valley and his talks with farmers there, his Government, while reserving its legal rights, had decided to stop using waters from the Wellton-Mohawk project for irrigation purposes while waiting for receipt of the US proposal for a definitive solution.

Both Presidents agreed to instruct their Water and Border Commissioners to prepare and sign a Minute containing the above program and commitments as soon as possible.

The Presidents discussed the many areas of ongoing cooperation between Mexico and the United States, and their conviction that such cooperation serves to bind our people even closer together in mutual effort and understanding. They took note of the agreements concluded during the visit by their respective Secretaries for Foreign Relations: a bilateral agreement with regard to the exchange of information, training and research in the fields of science and technology; a subsidiary agreement which contemplates the exchange of young technicians and scientists (including the training of some 100 young Mexican technicians and scientists through US Government agencies); renewal of the agreement on Cultural Relations.

President Nixon and President Echeverria discussed the serious nature of the illicit international traffic in narcotic drugs. They reviewed the joint enforcement measures which their countries have successfully undertaken over the past two years. President Nixon informed President Echeverria of

recent measures taken to combat the drug problem in the United States. They agreed to acquire and employ additional equipment in the antinarcotics campaign and to make available increased training of personnel for this purpose.

With regard to the question of migratory Mexican workers, the two Presidents discussed the economic, social and political factors that produce this problem and agreed it was desirable for each government to undertake immediately a study of this question with a view to finding a mutually satisfactory solution.

Recognizing the communality of many environmental problems and the need to seek cooperative solutions through the exchange of research and experience, the two Presidents have agreed that appropriate policy level officials from Mexico and the US will meet on a regular basis for discussion and consultation concerning current and future environmental problems of mutual concern and the methods for dealing with them in a more systematic way.

The conversations between Presidents Nixon and Echeverria were at all times cordial and marked by the spirit of good neighborliness which exists between Mexico and the US. At the same time problems were discussed frankly and openly as between true friends in an atmosphere of mutual respect and trust. President Echeverria particularly wished to convey on behalf of Mrs. Echeverria, his party and himself, his deep appreciation for the warm hospitality which was extended to them by President and Mrs. Nixon.

President Nixon expressed his great pleasure that President and Mrs. Echeverria will now have an opportunity to visit other areas and cities of the United States and assured them they will receive a warm and friendly welcome from the American people.

THE CONGRESS

Coordination of United States Foreign Economic Policy

Statement by Secretary Rogers [1]

I welcome this opportunity to expand on the brief exchange we had on this subject last March. Mr. Culver [Representative John C. Culver] asked me at that time whether I agreed that foreign economic questions had become more important in the context of our foreign policy and security interests. As I said then, I certainly do agree; indeed, in the introduction to my first foreign policy report in March 1971, I said that economic relations would undoubtedly figure more largely in the foreign policy of the United States and of other nations during the rest of the century. The subsequent events of last August and beyond have put into sharp relief the central role which economic policy must play in our international affairs.

Mr. Culver also asked whether the administrative arrangements within the U.S. Government were adequate to cope with these issues and, in particular, with their foreign policy implications. I said that I was not entirely satisfied with the functioning of the present mechanism for dealing with these problems. It is to this that I will devote my remarks today.

To place the matter in perspective, let me recall the economic and political developments which underlie and explain the diffi-

[1] Made before the House Committee on Foreign Affairs on June 20 (press release 144). The complete transcript of the hearings will be published by the committee and will be available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

SOUTHERN REGION
509 W. Fourth Street
Weslaco, Texas 78596

November 15, 1972

Dr. Oscar Brauer Herrera, General Director
Instituto Nacional de Investigaciones Agricolas
Departamento de Entomologia
Apartado Postal No. 6-882
Mexico 6, D. F.

Dear Dr. Brauer:

In view of the Mexico-United States agreement to carry the screwworm eradication program into Mexico as far as Tehuantepec, the Agricultural Research Service (ARS) is expanding studies in order to obtain data on the screwworm that will support the program as it moves into a more tropical environment. Also, ARS is presently developing a proposal with the United States Space Administration (NASA) for research on remote sensing to detect screwworm populations. Our scientists believe that a feasibility test on the use of remote sensing for this purpose could be carried out in Mexico.

If you agree that this research endeavor merits consideration, I can arrange to visit Mexico City on November 29th or 30th to discuss this research with you in detail. There is a possibility that H. Graham, on temporary duty at our Screwworm Research Laboratory in Mission, and C. M. Barnes, Public Health Ecology, NASA, Houston, will be able to meet with us in Mexico City.

Please let me know if either of the above days is convenient for you.

Sincerely,

Edgar A Taylor

E. A. Taylor
Acting Area Director

cc:
A. W. Cooper
C. M. Barnes
Kenneth A. Haines

ARS:SR:EATaylor:je 11-15-72

11-16-72 1:00 pm JE

The following statement was dictated by Jerry Barger and Dick Felch, Environmental Data Services, Washington, D. C. They stated that Dr. Barnes would like something to this effect inserted in the screwworm proposal.

The Agricultural Climotology Service Office, (ACSO), Environmental Data Service, NOAA, under its memorandum of understanding with the Department of Agriculture, is available to furnish meteorological consultations and assistance. The ACSO will help with the site selection, the location and installation of some 20-40 weather-observing stations, and the analysis of the data obtained. ~~It is~~ They have requested that ARS provide funds from which necessary instruments and site preparation expenses, as well as travel and per diem of participating personnel in ACSO, can be paid. These funds will total $4,000 distributed as follows: $2500 for instrumentation and site preparation and $1500 for travel and per diem. The Environmental Data Service is paying for the initial site visit and later expenses of coordination and analysis as may be possible.

Jerry Barger: Phone Office- 202 343/5262
Res. 301 622 0756

---------- Washington, D.C. 20235

November 17, 1972

Reply to
Attn of: D3x3

Mr. Edward Taylor
Entomological Research Group
USDA - ARS
Weslaco, Texas

Dear Mr. Taylor:

Dr. Barnes called me Wednesday, November 17th regarding the proposal your office is preparing for funding the Mexico test site as part of the screwworm eradication program through FY73. He asked me to come up with a cost estimate for establishing a network of weather stations in the test area.

We called your office yesterday and gave your secretary a statement, including some total costs. We estimate that $2500 will be required for instrumentation and $1500 for travel. We propose that each station have the following instrumentation:

Equipment	Approximate Cost
1 Small Instrument Shelter	$ 26.00
1 Max-min thermometer	11.70
1 Soil Thermometer	6.50
1 Precip Gauge	4.00
Total	$ 48.20

We may be able to get some of these items directly and reduce the cost directly. We may also want some measure of radiation. We have been told that the Mexican Meteorological Service has recently purchased 25 actinometers. We will try to get permission to use one or two of them. It may also provide a means of getting their Met Service involved or at least interested in our efforts.

In addition to the instrumentation, each site will require a post on which to place the instruments, and posts and fencing material to protect the area. Estimated cost of this would

be $25-40 per site. All required materials should be available locally.

The total cost of each site will be $75 to $90 per site. Assuming 30 sites are used, this will total $2350 - 2700. We feel $2500 would be a good value to work for.

As far as travel is concerned, we propose to pay our own expenses on the initial trip which will begin on November 26. We expect that two additional trips will be required, and are asking that they be funded through the proposal. The first trip would be as soon after the test site is operational as possible. The purpose of this trip would be the actual placement of the instruments at the predetermined sites and training of the observers. The second trip would be sometime later to check the status and quality of the observatory. We feel that $1500 would be sufficient to cover the cost of these trips.

If all the paperwork is cleared in time, I expect to be with you on the trip at the end of this month. I am looking fowward to meeting you.

Please extend our many thanks, on behalf of both Dr. Barger and myself, to your secretary, who was most helpful yesterday in your absence.

Sincerely,

Richard E. Felch
Agricultural Climatologist

REFelch:bvs

SOUTHERN REGION
509 W. Fourth Street
Weslaco, Texas 78596

November 17, 1972

Dr. Charles M. Barnes
Health Applications Office, DD 12
NASA - Manned Spacecraft Center
Houston, Texas 77058

Dear Dr. Barnes:

Attached please find the statement that you submitted concerning the proposed cooperation on remote sensing for screwworm. It has been revised after discussions with Dr. R. C. Bushland of the Screwworm Research Laboratory in Mission, and with ACSO personnel.

If any further action on our part is required, please contact us.

E. A. Taylor
Acting Area Director

1 Enclosure

cc:
H. C. Cox
W. Klassen
L. Henderson

ARS:SR:WGHart:je 11-17-72

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Work at the test site will be concentrated in the following tasks, which appear to be of most interest at this time. Density of screwworm flies as a function of time and physical variables will be measured by means of traps. The dynamics of infestation will be examined by means of wounded and newborn animals in the site.

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Studies of local ecology will be made as needed and may require experimentation with native and sterile flies. Weather variables will be measured for correlation with entomological and remotely sensed data. These data may well indicate that other tasks are needed at the test site.

ARS will furnish technical guidance by entomologists from its staff experienced in screwworm field studies. In addition, ARS under its cooperative agreement with the Instituto Nacional de Investigaciones Agricolas will provide professional services of at least one Mexican scientist. Further, ARS will furnish six local nationals to make collections from traps, take readings from weather stations, examine animals, and perform related tasks.

NASA is expected to furnish all costs of a qualified research entomologist from its contractor, the University of Texas. He will measure entomological and meteorological data for correlation with remotely sensed variables. ARS will work toward obtaining authorization from the Mexican government for him to work as a visiting foreign consultant in Mexico with all of the associated privileges.

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In support of the test site ARS has budgeted for and will furnish the equipment needed for field entomological studies. This will include one pickup truck, 120 fly traps, and operating expenses of the field studies. However, NASA will furnish a stereoscopic microscope for use of the entomologist in classifying trapped flies.

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NASA is expected to furnish all costs of a qualified research entomologist from its contractor, the University of Texas. He will measure entomological and meteorological data for correlation with remotely sensed variables. ARS will work toward obtaining authorization from the Mexican government for him to work as a visiting foreign consultant in Mexico with all of the associated privileges.

The Agricultural Climatology Service Office (ACSO), Environmental Data Service, NOAA, under its memorandum of understanding with the Department of Agriculture, is available to furnish meteorological consultations and assistance. The ACSO will help with the site selection, the location and installation of some 20-40 weather

observing stations, and the analysis of the data obtained. They have requested that ARS provide funds from which necessary instruments and site preparation expenses, as well as travel and per diem of participating personnel in ACSO, can be paid. These funds will total $4,000 distributed as follows: $2500 for instrumentation and site preparation and $1500 for travel and per diem. The Environmental Data Service is paying for the initial site visit and later expenses of coordination and analysis as may be possible.

In support of the test site ARS has budgeted for and will furnish the equipment needed for field entomological studies. This will include one pickup truck, 120 fly traps, and operating expenses of the field studies. However, NASA will furnish a stereoscopic microscope for use of the entomologist in classifying trapped flies.

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Please retype and to Henderson, Klass & cont
and copies Return to Ed Taylor
Jerry Barger
(reminder Rick Felch -
(revised by Bushland 11/14/72)

DRAFT:CMB:djm:11/6/72

STATEMENT

The USDA-ARS staff has read the NASA "Proposal for a Feasibility Test of the Use of Remote Sensing in Screwworm Eradication" and the report "Specific Operations of the Remote Sensing Operations Team (Proposed)" and wish to affirm the desire of the Agricultural Research Service (ARS), USDA, to cooperate with NASA in testing remote sensing in our screwworm eradication program. We agree to work toward the establishment of a cooperative work project at a test site in Mexico to determine the relation between remotely sensed variables and the ground observations of screwworm environmental factors. Such a site is planned to begin operations in January 1973 and continue to about June 1975 to allow thorough coverage of two complete annual cycles of screwworm infestation. Support of the operational phase of screwworm eradication program may begin as early as the sterile screwworm production facility at Tehuantepec is in full operation, provided that the feasibility has been demonstrated with studies made from the test site.

Work at the test site will be concentrated in the following tasks, which appear to be of most interest at this time. Density of screwworm flies as a function of time and physical variables will be measured by means of traps. The dynamics of infestation will be examined by means of wounded ~~penned animals and other~~ and newborn animals in the site. ~~Life tables will be constructed to relate the life cycle of the screwworm to the physical variables.~~

Studies of local ecology will be made as needed and may require experimentation with native and sterile flies. Weather variables will be measured for correlation with entomological and remotely sensed data. These data may well indicate that other tasks are needed at the test site.

~~It is planned that~~ ARS will furnish ~~two~~ entomologists ~~or technicians~~ from its staff ~~for assistance with all phases of the entomological~~ studies. ~~If ARS does not have such persons available it~~ will furnish ~~at least two~~ local nationals to ~~help~~ make collections from traps, take readings from weather stations, examine animals, and perform ~~relatively unskilled~~ tasks.

NASA is expected to furnish all costs of a qualified research entomologist from its contractor, the University of Texas. He will measure entomological and meteorological data for correlation with remotely sensed variables. ARS will work toward obtaining authorization from the Mexican government for him to work as a visiting foreign consultant in Mexico with all of the associated priviledges.

In support of the test site ARS has budgeted for and will furnish the equipment needed for field entomological studies. This will include ~~approximately three~~ pickup trucks, ~~twenty~~ fly traps, ~~35 micro weather stations, four pens, twenty sheep,~~ and other field equipment ~~that is relatively inexpensive~~. However, NASA will furnish a stereoscopic microscope for use of the entomologist in classifying trapped flies.

Studies of local ecology will be made as needed and may require experimentation with native and sterile flies. Weather variables will be measured for correlation with entomological and remotely sensed data. These data may well indicate that other tests are needed at the test site.

It is planned that ARS will furnish an entomologist as technician from its staff for assistance with all phases of the entomological studies. It is also hoped that one and possibly two will furnish [illegible] local nationals to help make collections from traps, take readings from weather stations, examine animals, and perform related [illegible] tasks.

NASA is expected to furnish all costs of a qualified research entomologist from its contractor, the University of Texas. He will measure entomological and meteorological data for correlation with remotely sensed variables. ARS will work toward obtaining authorization from the Mexican government for him to work as a visiting foreign consultant in Mexico with all of the associated privileges.

In support of the test site ARS has budgeted for and will furnish the equipment needed for field entomological studies. This will include approximately three pickup trucks, [illegible] fly traps, [illegible] and other field equipment [illegible] relatively inexpensive. However, NASA will furnish a stereomicroscope with scope for use of the entomologist in classifying trapped flies.

C. M. BARNES - DD 12
NASA MANSPACE CRAFT CENTER
HOUSTON, TEXAS

NOV 17 1972

Per USDA-NASA agreement urgent you attend and provide technical input for screw worm research area evaluation, instrument placement and personnel requirement meeting with Mexico Dept of Agriculture 27 Nov - 2 Dec, Mexico City. Precise location follows.

Ed Taylor
Area Director

968-7321

P.O. Box 267
Weslaco, Tex
78596

Telegram sent to Dr. C. M. Barnes per his request 11-17-72. 9:45 a.m.

Juanita

NOV 20 1972

National Program Staff
Beltsville, Maryland 20705

November 15, 1972

Subject: "Use of Remote Sensing in Screwworm Eradication"

To: R. H. Miller, Remote Sensing Coordinator, ARS

I am returning herewith the document which you sent with your reference slip dated October 26, 1972. I asked Dr. Bushland to review this document; his comments are as follows:

"Barnes has floated these all over ARS. I got one, so did Graham, so did Ed Taylor. I had to write a critique for Taylor to send in. I think that remote sensing to detect differences between arid conditions in which flies could not survive, and suitable habitats would help. Also since flies cannot fly at temperatures below 60°F, temperature sensing should be of help in mountain areas where Mexico has no weather stations. I don't know how much value to place on Barnes' ecological outline. If it doesn't cost too much it may be O.K."

My own view is that remote sensing can be of considerable value. However, I am concerned that we will give higher priority to cooperation with NASA than to meeting our own research needs. If there are any available funds to increase screwworm research, priority should be given to development and field evaluation of better strains. Also we should make a much greater effort to monitor the impact of released screwworms on the fertility of the wild populations. Attractants and traps need development. Screwworms produced from the artificial diet are not as robust as those reared in wounds. Obviously nutritional studies should be made to improve the diet and to evaluate the longevity, ability to withstand stress, and flight range of screwworms reared on various diets. These and other needs should be given priority over a major involvement in remote sensing.

Waldemar Klassen

Waldemar Klassen
Staff Scientist
Pest Management

cc:
L. S. Henderson
R. C. Bushland
E. A. Taylor
H. O. Graumann

NOV 20 1972

National Program Staff
Beltsville, Maryland 20705

November 15, 1972

Subject: "Use of Remote Sensing in Screwworm Eradication"

To: R. H. Miller, Remote Sensing Coordinator, ARS

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Waldemar Klassen

Waldemar Klassen
Staff Scientist
Pest Management

cc:
L. S. Henderson
R. C. Buchland
E. A. Taylor
H. O. Graham

Mr. Taylor:

I called Washington to try to contact Dick Felsh but was unable to do so. I talked to Jerry Barger and he stated that Dr. Felsh had left Washington this morning at 8:45 am and was on his way to Mexico City. I told Dr. Barger that you had had to delay your plans for the meeting and would be unable to go but that Dr. Graham and Mr. Rodriguez were going ahead. Also, that Dr. Barnes had called you and that he was also going to be there. I told him we had not heard back from Dr. Brauer. Dr. Barger said that since Dr. Barnes, Dr. Graham and Mr. Rodriguez were going, he felt Dr. Felsh could go ahead and meet with them on this matter.

Juanita

Mr. Taylor.

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counter bad luck high but was
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Juarita

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA SERVICE
~~Silver Spring, Md. 20910~~ Washington, D.C. 20235

NOV 24 1972

November 17, 1972

Reply to
Attn of: D3x3

Mr. Edward Taylor
Entomological Research Group
USDA - ARS
Weslaco, Texas

Dear Mr. Taylor:

Dr. Barnes called me Wednesday, November 17th regarding the proposal your office is preparing for funding the Mexico test site as part of the screwworm eradication program through FY73. He asked me to come up with a cost estimate for establishing a network of weather stations in the test area.

We called your office yesterday and gave your secretary a statement, including some total costs. We estimate that $2500 will be required for instrumentation and $1500 for travel. We propose that each station have the following instrumentation:

Equipment	Approximate Cost
1 Small Instrument Shelter	$ 26.00
1 Max-min thermometer	11.70
1 Soil Thermometer	6.50
1 Precip Gauge	4.00
Total	$ 48.20

We may be able to get some of these items directly and reduce the cost directly. We may also want some measure of radiation. We have been told that the Mexican Meteorological Service has recently purchased 25 actinometers. We will try to get permission to use one or two of them. It may also provide a means of getting their Met Service involved or at least interested in our efforts.

In addition to the instrumentation, each site will require a post on which to place the instruments, and posts and fencing material to protect the area. Estimated cost of this would

be $25-40 per site. All required materials should be available locally.

The total cost of each site will be $75 to $90 per site. Assuming 30 sites are used, this will total $2350 - 2700. We feel $2500 would be a good value to work for.

As far as travel is concerned, we propose to pay our own expenses on the initial trip which will begin on November 26. We expect that two additional trips will be required, and are asking that they be funded through the proposal. The first trip would be as soon after the test site is operational as possible. The purpose of this trip would be the actual placement of the instruments at the predetermined sites and training of the observers. The second trip would be sometime later to check the status and quality of the observatory. We feel that $1500 would be sufficient to cover the cost of these trips.

If all the paperwork is cleared in time, I expect to be with you on the trip at the end of this month. I am looking forward to meeting you.

Please extend our many thanks, on behalf of both Dr. Barger and myself, to your secretary, who was most helpful yesterday in your absence.

Sincerely,

Richard E. Felch
Agricultural Climatologist

be $25-40 per site. All required materials should be available locally.

The total cost of each site will be $75 to $90 per site. Assuming 30 sites are used, this will total $2250 - 2700. We feel $2500 would be a good value to work for.

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Please extend our many thanks, on behalf of both Dr. Barger and myself, to your secretary, who was most helpful yesterday in your absence.

Sincerely,

Richard E. Felch
Agricultural Climatologist

MEMORANDUM OF UNDERSTANDING

This is an informal memorandum of understanding between the Health Applications Office, NASA and various staff members of the Agriculture Research Services, USDA.

1. SUPPORT.- NASA expects to support the screwworm test phase program at the rate of $160,000 per year beginning April 1, 1973. The Department of Agriculture expects to support the program at approximately $_____ per year during this same period of time.

2. STAFF.- It is agreed that a screwworm test site will be operated within the Republic of Mexico for the purpose of determining whether remote sensing systems can define the environmental habitat of the screwworm fly. The NASA staff will be composed of at least one contractor or Civil Service staff member within the test site at all times. He will direct the taking of ground data within the test site to determine the efficiency of aerial remote sensing systems. Agriculture agrees to furnish funds for a counterpart Mexican citizen who will accompany the NASA staff member. In addition, they will provide funds for 3 to 5 additional Mexican Nationals within the test site for supporting activities. Depending on the number of staff, it is expected that at least 3 vehicles will be provided to

the test site team with Agriculture funds.

3. SITE.- The precise location of the test site will be defined by the staff upon arrival in Mexico and, in general, agreement with U.S. and Mexican NASA and U.S. and Mexican Agriculture.

4. IMPLEMENTATION.- The test site shall begin operations on or about May 1, 1973 with the arrival of personnel and as much equipment as soon thereafter as possible. Test site activities will proceed for approximately 2 years, at which time an evaluation will be made by both Agriculture and NASA as to the validity of current concepts in the use of remote sensing. At that time, a decision will be made relative to whether remote sensing will be used in the major eradication program.

5. SCIENCE PROTOCOL.- The test site team will collect the following ground truth information:

a. Basic climatology of the area

b. Reflectance values of dry and wet soil and vegetation

c. The local incidence of screwworms within the animal population as related to temperature, altitude, vegetative cover, water sources, soil moisture, and animal population. Remote sensing data will be collected with an aircraft inventory flight during the

second quarter of CY 73. Basic purpose is to determine the local topography and reflectance value of vegetative cover and soil in the area, as well as providing a basic map of the region. The Earth Resources Technology Satellite (ERTS) data will also be collected over the test site to provide similar information from 500 miles altitude. The Improved Tiros Operational Satellite (ITOS) will also be querried at intervals, seeking similar information as that from the aircraft and ERTS.

6. SCHEDULE.- NASA funding is currently available to accomplish the above schedule. It is anticipated that meetings with Mexican/NASA officials will be conducted in the immediate future--early April and that approval of all NASA participants will be received no later than April 15, 1973. The test site will be agreed upon not later than April 15. Vehicle deliveries to the ~~American Embassay,~~ Test Site Teqwn Mexico City, should begin _____. Meterological equipment is on order and is expected to arrive at the American Embassay, Mexico City approximately May 15, 1973. Data from ITOS and ERTS is currently being made available to Houston Office of NASA and routine processing proceedures should be completed not later than May 1, 1973.

Screwworm Lab

DEC 15 1972

Mr. E. A. Taylor Ed

DD12

DEC 13 1972

Dr. R. C. Bushland
Agricultural Research Service
USDA Screwworm Research Station
Mission, TX 78572

Dear Dr. Bushland:

The Health Applications Office, Manned Spacecraft Center, NASA, is most anxious to acquaint you with details of the capabilities of remote sensing as applied to problems of agricultural research. Of particular importance is our current commitment to assist in defining the geographic-ecological parameters associated with the screwworm fly in Mexico.

We would be honored to host you at our laboratories located near Houston, Texas at any time convenient with your schedule. We sincerely hope that you can visit us soon. For purpose of coordination, our office telephone number is (713) 483-5406.

Sincerely,

Original Signed By
Charles M. Barnes

Charles M. Barnes, D.V.M., Ph. D.
Manager, Health Applications Office

DD12/CMBarnes:djm:12/12/72:5406

bcc:
Mr. E. A. Taylor - Weslaco, TX

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA SERVICE
Washington, D.C. 20235

DEC 26 1972

Screwworm file

December 21, 1972

Reply to
Attn of: D3

Mr. Edward Taylor
Entomological Research Group
USDA - ARS
Weslaco, Texas

Dear Mr. Taylor:

As you requested, Dr. Felch and I have reviewed our potential role in the proposed project in Mexico on the study of the native ecology of the screwworm fly in cooperation with NASA and USDA. Primarily, we can provide climatological assistance and consultation on experimental site selection, sampling plans, recommended instrumentation and eventual analysis of the data collected.

We see three major efforts needed relating weather to the behavior of the screwworm fly and all three can be carried out simultaneously. The first will be to provide response data in terms of fly activity, as measured by the number of trapped flies and/or the number of animal infectations observed in the area. The second task will be to provide a network of ground truth observations for use with the satellite observations. Finally it will be important to look at the effects of weather on vegetation to determine whether or not vegetation is a better indicator of fly activity than just weather data per se. All of this information can then be used in refining a model for predicting screwworm activity.

As you are aware, Dr. Felch was in Mexico earlier this month to look over the proposed test site in the Cordoba area. Once the program has progressed to the point where the weather stations will be installed, one of us will make another trip to assist in specific site selection, installation of instruments and training individuals on the use and care of stations.

We feel that a network of 20 recording stations and 10 smaller stations would be adequate for this experiment. The stations will be described in detail later. Originally it was planned to use inexpensive equipment which would have been read daily, hopefully utilizing local farmers and ranchers to take the observations. After discussing this problem with

Drs. Graham and Rodrequez, it was agreed that stations which needed to be checked only once a week would be much more satisfactory. We were concerned about the difficulty in finding a sufficient number of willing and reliable people to take the readings daily. Using recording equipment increases the cost considerably over what we had originally estimated in our letter of November 17, copy attached.

The key parameters to be studied are temperature and precipitation. Therefore, each station will require a recording thermograph and a rain gauge which can accumulate a week's rainfall with a minimum of evaporation. The thermograph would require a small shelter and stand. The cost of such a station (based on Weatherwise catalog) is approximately $193.00 and consists of the following:

1 Thermograph Model T611	$120.00	9/134.05
1 Forester's Rain Gauge Model P569	23.00	
1 Shelter (built locally)	50.00	
	$193.00	

The 20 stations plus, say, 5 replacement sets @ $193.00 would cost $4825.00. In addition about 5 soil thermometers will be needed costing $6.50 each or $32.50 total.

As the program develops Dr. Rodriquez will no doubt find ranchers and farmers who would like to have a station of their own. It should be noted that all of the above 20 stations will most likely be located on various farms and ranches where they can be watched for security purposes. To help increase the interest of other ranchers who request a station of their own, we suggest that equipment for secondary stations be purchased for distribution as needed or requested. Such a station would include a simple max-min thermometer, fence post rain gauge and a slatted shelter which probably would be constructed locally at little cost. The thermometer is $11.70, the rain gauge $2.00 and a shelter could be built for about $10.00. Thus we are talking approximately $24.00 per station. Ten of these stations would probably be sufficient. Thus it would cost an additional $240.00 for these stations, but they would provide excellent public relations and would also supplement our network of data, especially the highly variable precipitation element.

Particularly with the recording stations, some kind of protection will be needed. This would be mainly some wire and fence posts to prevent livestock from damaging the equipment and to deter curious people, particularly children. Each station would require four fenceposts and about 100' barbed wire.

Drs. Graham and Rodriguez, it was agreed that stations would needed to be checked only once a week would be much more satisfactory. We were concerned about the difficulty in finding a sufficient number of willing and reliable people to take the readings daily. Using recording equipment increases the cost considerably over what we had originally estimated in our letter of November 17, copy attached.

The key parameters to be studied are temperature and precipitation. Therefore, each station will require a recording thermograph and a rain gauge which can accumulate a week's rainfall with a minimum of evaporation. The thermograph would require a small shelter and stand. The cost of such a station (based on weathertwise catalog) is approximately $188.00 and consists of the following:

1 Thermograph Model T811	$120.00
1 Forester's Rain Gauge Model P589	28.00
1 Shelter (built locally)	40.00
	$188.00

The 30 stations plus, say, 5 replacement sets @ $188.00 would cost $9425.00. In addition about 5 soil thermometers will be needed costing $6.50 each or $32.50 total.

As the program develops Dr. Rodriguezwwill no doubt find ranchers and farmers who would like to have a station of their own. It should be noted that all of the above 30 stations will most likely be located on various farms and ranches where they can be watched for security purposes. To help increase the interest of other ranchers who request a station of their own, we suggest that equipment for secondary stations be purchased for distribution as needed or requested. Such a station would include a simple max-min thermometer, fence post rain gauge and a slatted shelter which probably would be constructed locally at little cost. The thermometer is $11.70, the rain gauge $2.00 and a shelter could be built for about $16.00. Thus we are talking approximately $24.00 per station. Ten of these stations would probably be sufficient. Thus it would cost an additional $240.00 for these stations, but they would provide excellent public relations and would also supplement our network of data, especially the highly variable precipitation element.

Particularly with the recording stations, some kind of protection will be needed. This would be mainly some wire and fence posts to prevent livestock from damaging the equipment and to deter curious people, particularly children. Each station would require four fenceposts and about 100' barbed wire.

The travel cost contained in Dr. Felch's letter of November 17, 1972 would remain the same. His recent trip expense was paid by us to get things going. Dick suggested two additional trips but three might be required if anything goes wrong during the period of experimentation. About $1500 total is requested. This would include travel to and from Mexico and per diem while in Mexico. Any per diem in the U.S. associated with the effort would be paid through our funds, such as time in Mission or Houston. In addition, we have some dew recorders we can furnish if dew is a likely source of water for the flies. Present type of recorder requires 110 volt current, however.

So the total support (some travel would fall in FY74 and/or FY75) requested from ARS is:

25	Primary station equipment sets	$4825.00
5	Soil thermometers	32.50
10	Secondary station equipment sets	240.00
	Travel	1500.00
		$6598.00

This doesn't include fencing which I trust can be obtained locally. I believe the amount you have been given previously is $6600 also; obviously there will be deviations in actual cost but we can balance these out if some such amount can be made available. We can use the dollars available in Mexico if desired.

It should be noted that all the instruments would be procured in the U.S. and read in English units. We will look into the possibility of metric units and of course if suitable equipment can be purchased in Mexico that is satisfactory.

If you have any questions please call me on 202-343-5262 or Dick Felch at 202-447-7919.

Sincerely yours,

Gerald L. Barger

Gerald L. Barger
Director, Laboratory for
Environmental Data Research

The travel cost contained in Dr. Felch's letter of November 17, 1972 would remain the same. His recent trip expense was paid by us to get things going. Dick suggested two additional trips but three might be required if anything goes wrong during the period of experimentation. About $1800 total is requested. This would include travel to and from Mexico and per diem while in Mexico. Any per diem in the U.S. associated with the effort would be paid through our funds, such as time in Mission or Houston. In addition, we have some dew recorders we can furnish if dew is a likely source of water for the fifes. Present type of recorder requires 110 volt current, however.

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Travel	1800.00
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If you have any questions please call me on 202-343-5202 or Dick Felch at 202-447-7319.

Sincerely yours,

Donald L. Harper
Director, Laboratory for
Environmental Data Research

DEC 29 1972

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ROUTING SLIP

MAIL CODE	NAME		
		Action	
		Approval	
USDA	MR. TAYLOR	Call Me	
		Concurrence	
		File	
		Information	
		Investigate and Advise	
		Note and Forward	
		Note and Return	
		Per Request	
		Per Telephone Conversation	
		Recommendation	
		See Me	
		Signature	
		Circulate and Destroy	

Thought this might interest you.

Screwworm

Charlie

NAME	TEL. NO. *(or code)* & EXT.
CHARLES M. BARNES, MANAGER HEALTH APPLICATIONS OFFICE DD121 NASA-MSC HOUSTON, TEXAS 77058	(713)483-5406
CODE *(or other designation)*	DATE 12-27-72

NASA FORM 26 APR 69 PREVIOUS EDITIONS MAY BE USED

GPO : 1969 OF—348-365

Contract NAS 9-12200
Job Order No. 79-905

TECHNICAL MEMORANDUM

THE EFFECTS OF THE ENVIRONMENT OF THE DIFFERENT STAGES OF THE SCREW-WORM FLY COCHLIOMYIA HOMINIVORAX

BY

A. B. Thiermann

Approved: R. E. Tokerud
Manager
Earth Observations Department

Distribution:

MSC: C. M. Barnes (7)
L. F. Childs
C. E. Fuller
H. J. Schneider
LEC: L. E. Giddings

December 13, 1972

LOCKHEED ELECTRONICS COMPANY, HOUSTON AEROSPACE SYSTEMS DIVISION

THE EFFECTS OF THE ENVIRONMENT ON THE

DIFFERENT STAGES OF THE SCREWWORM FLY

COCHLIOMYIA HOMINIVORAX

INTRODUCTION: This is a compilation of statements of fact from the technical literature. These statements have not been critically judged, and therefore some are not consistent with others. The different environmental conditions which can affect or limit the development of this insect are listed under each stage.

EGG: Eggs are about 1.04 mm long with a diameter of 0.22 mm. They come in egg masses from 10 to 393 eggs each.[2] One female can deposit up to 300 eggs in 4-6 min.[2] In captivity one female layed a maximum of 2,853 eggs at 80°F and died at 60 days of age.[2] The incubation under laboratory conditions is 9 hours 34' at a temperature of 101° -90°F. In animal wounds under natural conditions, it is 11-21.5 hours.[2]

Experimentally, under 100% humidity, incubation lasted 9.2 hours at 99°F and 13.9 hours at 84°F. Eggs did not survive at 59°F.[2] In the laboratory, incubation in a guinea pig wound lasted 6 hours.[2] Incubation normally takes 8 hours, but because of weather it can take up to 24 hours.[3] Eggs frozen at 16 - 17°F did not hatch.[2]

LARVAE: The larval stage averages 6 days, but it can endure up to 10 days at any low temperature which is not fatal to the host.[3] The larvae penetrate deeper in the wound when it gets colder.[3]

Larvae were able to complete development in a dead body in laboratory conditions, provided that the body was alive until the larvae reached the second instar stage. The period lasted 36 to 96 hours at 86° - 52.4° F.[2]

The soil surface temperature is the real parameter which should be noted during the larvae drop.[1]

Larvae that drop in cool weather penetrate deeper into the soil. Larvae dropping at air temperatures below 40°F become immobile unless the soil has a higher temperature. Between 15° - 20°F they die.[3] At the end of the larval period, most larvae leave the wound between 9 a.m. and 2 p.m. Larvae subjected to desiccation produce undersized papae.[4]

PREPUPAE: This period, from 0 to 48 hours after the larvae leave the wound, is very critical for desiccation.[4] This period varies from 7-76 hours depending on the environment.[2] When frozen at 13 to 23°F all the prepupae died.[2]

The heavier the soil, the deeper they go. They penetrate 7.77 inches deep (maximum 17 in.) in clay, 2.48 inches (maximum 13 inches) in heavy black soil, 2.25 inches (maximum 6 inches) in sand, and 1.87 inches (maximum 3 inches) in gravel.[2]

PUPA: The average pupa is 10.2 mm by 4.3 mm.[2] The duration of the pupal period in nature is 167 hours (7 days) in the summer and 54 days in winter.[2] In laboratory conditions at 100% humidity, the duration was found to be 142.2 hours for 94°F, 760.4 hours for 59°F.[2] Another reference lists 10 days for 75°, 15 days for 70°, and 30 days for 60°F.[3]

Under laboratory conditions, at 4 inches, with air temperature of 18° to 83°F and soil temperature 40° to 70° for 41 to 44 days, 36.3% of the pupae hatched and the rest died.[2] When frozen at 18-20°F, 40% of

the pupae emerged.[2] Pupae held at fairly constant temperature near 55°F rarely produced adults. The lower the moisture, the higher the emergence between 50 and 60°F.[3]

The lowest average daily mean air temperature at which the pupae have produced adults from larvae on dry range soil was 47.6°F. The lowest air temperature to which pupae have been exposed and produced adults was 17°F. They did not survive at 15°. Pupae have rarely survived in frozen soil with a moisture content high enough to freeze the soil solid.[3]

When cold weather prolongs the pupal stage beyond 50 days, emergence drops to 1-2%. Longest pupal stage recorded was 77 days. Moisture affects percentage of adults emerging from pupae.[3]

ADULT: Feeding and normal activities begin at 60°F. Few flies revive after being subjected to temperatures of 20°, and none have survived from lower temperatures. The percentage of dropped flies making normal recovery rises from approximately 1% at 20° to 90% at 32°. Abrupt and sudden changes in temperature are usually fatal to a high percentage of adults.[3]

Adults are normally inactive at night. Normal activity begins soon after sunrise and ends shortly after sunset. They seek the lightest areas and usually the brightest sunshine under natural conditions except at high temperatures. They are less active on cloudy days and become inactive with heavy clouds.[3]

Adult activity is retarded by winds of 5 to 6 miles an hour and

is prevented by winds as high as 15 mph. They are inactive during continuously rainy periods.[3] Their nocturnal resting places have been found to be along streams on 4-5 feet high leafless twigs overhanging pools of water. No flies have been found on dry streams.[5]

Flies do not inhabit heavy, dense forests. They are found more commonly in bush areas than on prairies or open plains, mainly because of winds. They have never been found resting on buildings, caves, burrows or any deep shade, but they do visit these places to oviposit.[3]

Daily ranges of as much as 40-50° markedly shorten the life of adults when minimum temperatures are below 30°. If they survive hot-cold shocks they live longer (30 days).[3]

Adult flies have survived undercooling temperatures (19°) and freezing (23°) and layed fertile eggs. Adult life is short (2 weeks) if mean temperature is over 70°.[10] Adult flies need liquid water every 2 hours. They can survive on condensation on mesquite trees.[1] The adults appear to have their longest life span during cool, moist weather. The maximum life span for an adult was 76 days.[3] A minimum temperature of 24° apparently did not kill adults.[6]

Experiments determined that maximum life span for a generation from oviposition until the death of the last adult is 2.5 to 3 months (max. 121 days). The effective maximum generation span in nature is probably less than 100 days. The maximum experimental life span including all stages was 164 days.[3]

The life cycle, from egg to the female laying eggs, lasts 24 days at a mean air temperature of 72°.[2] The lowest air temperature in nature

recorded when a female oviposited was 65°.[2] The lowest maximum temperature where oviposition was detected was 63.5° on a 100% cloudy day.[6]

The maximum number of successful matings have been found to be on 3 day old flies, and oviposition reached a maximum on 5-day-old flies. Males mated more frequently in light. It is believed that a visual stimuli may be important in orientation of males and females. Stock flies mate satisfactory in dark, perhaps because of natural genetic selection.[7]

Females can store viable sperms in spermatheca for an average of five days after copulation, and a maximum of 15 days.[7]

There is some evidence that females can mate more than once under atypical conditions.[7]

The minimum temperature recorded during active infection was 16° (1934).[2] Increases of infestation follows periods of rainfall from 1 inch or more, up to 3 inches a week. The type of rain is important; small amounts and small periods of rain are better.[1]

The fly population decreases considerably when the monthly average of daily mean temperatures falls below 60°. Flies generally emerge early in the morning (4-7 AM), and in a few hours they are ready to fly. After five days the females can deposit fertile eggs.[3]

The lowest mean temperature for a period of three months (Dec. - Feb.) where they overwintered was 49.2°F. The highest mean where they did not overwinter was 50.3°. The daily mean temperature marking the survival limit for the five month period was 53°. The lowest mean temperature at which they overwintered was 53.3°, and the

highest mean temperature at which they did not overwinter 53.8°. No instance has been found in the U. S. where they remained continually present in which the annual average of the monthly mean was below 67°.[3]

For shorter periods than three months the average daily mean temperature is not very reliable as an index to the trends of the fly population and activity; shorter periods than that must be studied as nonrecurring shock factors.[3]

A five month period with 0.4 inches per month of rainfall is the limit of tolerance for overwintering. The maximum rainfall tolerance is 5 inches a month. The highest population was reached between 1.5 and 3 inches a month.[3]

In nature alkalinity and acidity of the soil is of no importance in the emergence of adults.[8]

Some very important factors to be considered in the overwintering areas are the number of flies at the beginning of the winter, the type of host material, the temperature and rainfall types rather than averages.[3]

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